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ABSTRACT

To assess the relationship between the competencies taught in ten Wisconsin two-year Associate Degree Electronic Technology programs and the competencies needed on the job, a study surveyed program graduates and employers of graduates regarding the effectiveness of the curriculum. The survey instruments were based on the 120 broad competencies developed for ten required Electronic Technology courses offered at Gateway Technical Institute which was implementing competency-based Education. Graduates were asked to complete a questionnaire asking if they were working as electronic technicians or in a related field; they were also asked to complete a survey on which they reacted on a Likert-type scale regarding importance of job, preparation at school, and adequacy of instructional equipment for each competency. Some graduates were also interviewed. The employer survey requested scaled reactions regarding importance of job and preparation at school. Responses were summarized for graduates working as electronic technicians and in related fields; for employers; for comparison of graduates and employers; and for the interviews. Employers and graduates were also asked three survey questions concerning qualification in job-entry skills, the two areas of best preparation, and the two areas of least adequate preparation. (Survey instruments are appended.) (YLB)

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Final Report
Project #06-050-150-319

ELECTRONICS TECHNOLOGY
CURRICULUM STUDY

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U.S. DEPARTMENT OF HEALTH,
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Keith W. Stoehr
District Director

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FOREWORD

This study was conducted with the intent that the information obtained could be used by Wisconsin Electronic Technology Programs to provide contact with graduates and their employers in an effort to validate the competencies needed in the Electronics Technology field.

In general, it is constructive to look at what we are doing for our graduates and the people that employ them. This research effort is an attempt to obtain input from these groups and to incorporate the findings of this research into the Electronic Technology curricula. To evaluate the effectiveness of the existing Electronic Technology programs, a special effort was made to compare the required competencies as perceived by the employers and by the graduate-employees from this program.

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Chapter I

INTRODUCTION

The Problem

The Electronic Technology two-year Associate Degree program is one of the older programs offered within the Wisconsin System of Vocational, Technical and Adult Education. Presently, the program is available at eleven institutions: Blackhawk Technical Institute, Eau Claire Technical Institute, Fox Valley Technical Institute, Gateway Technical Institute, Indianhead Technical Institute, Lakeshore Technical Institute, Madison Technical Institute, Milwaukee Area Technical College, North Central Technical Institute, Waukesha Technical Institute and Western Technical Institute.

Up to this point, there has been very little communication between the schools concerning the Electronics Technology program. A look at the catalogs from the different schools shows a great many similarities in curriculum even though the hours required, required courses and elective courses may differ.

The institutions offering the Electronics Technology programs are interested in providing the most effective program possible to best meet the needs of students enrolling and the industry the program is designed to serve. There has been no previous statewide evaluation of the curricula for this program. Little is known about the effectiveness of this program in preparing competent employees for entry in the world of work.

Objective

The major objective of this study is to assess the effect of competencies taught in the Wisconsin Vocational, Technical and Adult Education System. The specific objectives of the study will be:

1. To develop an instrument to evaluate the Electronics Technology program.
2. To interview a random sample of graduates of the Electronic Technology programs from the ten institutions taking part in this survey (Eau Claire chose to run their own survey) to determine the strengths and limitations of the present curriculum.
3. To survey a larger sample of the graduates, via mail questionnaire to determine the strengths and limitations of the present program.
4. To survey employers (where the graduates give permission) to determine the strengths and limitations of the program.
5. To analyze the responses of these surveys and interviews to determine the findings of the study.
6. To reach conclusions, give directions and recommendations for the improvement of the Electronic Technology curriculum at the institutions.

CHAPTER II

METHODOLOGY

On May 16, 1979, it was decided that the survey instrument should be based on the broad competencies being developed at Gateway Technical Institute for its Electronic Technology program. Gateway is in the process of switching over all of its programs to Competency Based Education (CBE). It was decided to use the 120 broad competencies developed for the ten required Electronic Technology courses offered at Gateway. It was realized that this would make the survey instruments long but it was also felt that no course should be omitted. Thus, the survey was to concentrate on the ten program courses and omit the general education courses. On June 12, the survey instruments (graduate and employer), cover letters, record forms & procedure were approved at a meeting attended by Joe Myrick of the State Board and the following Gateway personnel: Nicholas Covelli, Jack Banerdt, Harold Sahakian, Dave Petkovsek and Melvin May.

On May 15, 1979, Doyle Beyl and Arnold Potthast of the State Board asked each of the eleven schools offering Electronic Technology to provide the principle investigator with a list of the 1975, 1976, 1977 and 1978 graduates of Electronic Technology and their employers if known. As each graduate list was received, some names were randomly selected for interviews and the rest were mailed an instrument. The first mailing to graduates was sent June 21, 1979. Eau Claire chose to run their own survey; thus, ten schools took part in this research. The last school got their list in on July 2, 1979. If the instrument wasn't returned in a reasonable time, an effort was made to contact the graduate by phone without much success. The graduate instrument was accompanied by a questionnaire asking if he or she was working as an Electronic Technician or working in a related field. Permission to contact the graduate's employer was also requested. Copies of the questionnaire and survey instrument may be found in Appendix C. The survey instrument consisted of a listing of 120 competencies on which the graduate was requested to react on a Likert-type scale regarding Importance on Job, Preparation at School and Adequacy of Instructional Equipment for the Electronic Technology program at the technical institute they attended.

If the graduate response gave permission to contact the employer, the employer was called and then sent a survey instrument. This survey instrument consisted of a listing of 120 competencies on which the employer was requested to react on a Likert-type scale regarding Importance on Job and Preparation at School. Copies of the employer survey instrument may be found in Appendix E.

Those graduates that were selected for interviews were first contacted by phone to set up an appointment and then were mailed the same survey instrument as used for the other graduates. In many cases phone contact was unsuccessful. Thus to get more interviews, some graduates who had returned the mail instrument were called and interviewed if willing.

When the data had been collected, it was tabulated, analyzed and reviewed for purposes of evaluation. Statistical tabulations consisted of computing a mean and standard deviation for each competency. The competencies were then ranked according to mean for each one of the ten required courses. The following criterion was used to analyze the calculated mean and standard deviation:

Importance on Job

Mean less than 1.40 competency is not essential.

Mean greater than 4.00 competency is essential.

Standard Deviation greater than 1.81 indicates very low agreement.

Preparation at School

Mean less than 2.00 indicates a weakness.

Mean greater than 3.50 indicates a strength.

Standard Deviation greater than 1.81 indicates very low agreement.

Adequacy of Instructional Equipment

Mean less than 1.50 indicates a weakness.

Mean greater than 2.00 indicates a strength.

Standard Deviation greater than 1.21 indicates very low agreement.

Chapter III

Graduates Working as an Electronic Technician

The graduate survey instrument was sent out to 220 graduates. The returns included 36 Working as an Electronic Technician, 14 Working in a Related Field and five Not Working in Electronics nor a related field. We also had 28 returned because of no forwarding address. When the returns were slow in coming in, we tried to obtain phone numbers for a follow up.* In some cities, the phone operator couldn't find a phone number under the name and address given us by the schools. After getting some phone numbers, the phone follow up met with mixed success. In some cases, we got no answer, in some, the graduate said the form was too long and in others, the graduate then went ahead and returned the survey.

In completing the competency list, graduates were requested to respond to three different questions for each competency.

1. The importance of this competency on the job.
2. The adequacy of preparation for this competency at school.
3. The adequacy of the instructional equipment for learning this competency.

Items were ranked on a Likert-type scale. Importance on Job was ranked from 1, no knowledge necessary, to 5, knowledge essential; Preparation at School was ranked from 1, unprepared, to 5, excellent preparation; and Adequacy of Instructional Equipment was ranked from 1, poor, to 3, excellent. The rank, mean and standard deviation for the response of the graduates working as Electronic Technicians to the three questions are shown in tables 1 through 10 for the 10 Electronic Technology program courses. See Chapter IV for the results of the graduates working in a related field.

Summary of responses from graduates working as Electronic Technicians. Refer to the criterion given in Chapter II:

Importance on Job

Least Importance

Mean	Table	Competency
1.47	1	Design different meters using a DC meter movement.
1.47	6	Find the harmonics present in a mixer.
1.47	9	Graph curve of variable reluctance phase shift circuit.
1.69	5	Model a transistor circuit for AC or DC in order to obtain transfer function.
1.72	1	Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Note: No mean is below 1.40.

*Some of the schools were able to help.

Most Importance

Mean	Table	Competency
4.58	3	Identify standard electronic symbols and diagrams.
4.50	4	Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.
4.47	1	Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.
4.47	10	Use test equipment to troubleshoot the malfunctions of electronic equipment.

Standard Deviation -- Table 10 shows the largest number of competencies with a large deviation. Six competencies are between 1.65 and 1.81. This probably shows that some graduates work with computers and others don't. Note: No deviation is greater than 1.81.

Preparation at School

Poorest Preparation

Mean	Table	Competency
2.17	10	Use control bus for external controllers
2.28	1	Describe the properties of permanent magnetism and electromagnetism.
2.28	8	Connect and test the phase lock loop circuits.
2.31	6	Find the harmonics present in a mixer.
2.36	6	Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.
2.39	6	Simplify circuits using decibels and Miller's theorem.

Note: No mean is below 2.00.

Best Preparation

Mean	Table	Competency
4.33	1	Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's law.
4.11	1	Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc
4.11	1	Define electrical quantities such as potential, current, resistance, conductance, power and energy.
4.03	5	Identify the characteristics of semiconductors and properties of PN junction.
4.00	1	Verify series and parallel circuit operation using Kirchoff's Law.

Standard Deviation -- All deviations are less than 1.65. This means that all of the graduates agree very well on their preparation at school.

Adequacy of Instructional Equipment

Poorest equipment

Mean	Table	Competency
1.53	10	Use control bus for external controllers.
1.58	10	Interface microprocessor with I/O.
1.58	6	Find the harmonics present in a mixer.
1.61	2	Select chassis hardware for a given project.

Note: No mean is below 1.50.

Adequacy of Instructional Equipment (continued)

Best equipment Mean	Table	Competency
2.53	1	Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.
2.53	1	Calculate and verify series-parallel circuits using network theorems.
2.50	1	Define electrical quantities such as potential, current, resistance, conductance, power and energy.
2.50	4	Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Standard Deviation -- All deviations are less than 0.85. This means that all of the graduates agree very well on their equipment at school.

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 1

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenins theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.47	0.80	2.5	4.11	0.88	1.5	2.53	0.50
2	4.06	0.91	2.5	4.11	0.91	3	2.50	0.72
3	3.56	1.04	1	4.33	0.33	4	2.47	0.66
8	2.42	1.01	4	4.00	0.85	6	2.39	0.50
10	2.22	1.17	6	3.75	0.95	1.5	2.53	0.64
14	1.47	1.01	10	3.08	1.21	10.5	2.00	0.74
5	2.72	1.02	8	3.61	0.86	8	2.28	0.52
4	2.97	1.30	5	3.94	0.91	5	2.44	0.55
7	2.44	0.64	13	2.75	1.04	13	1.86	0.57
9	2.33	1.39	14	2.28	0.95	10.5	2.00	0.62
13	1.72	1.09	11	3.00	0.91	12	1.94	0.52
6	2.61	1.30	7	3.72	0.95	7	2.31	0.47
12	1.97	1.16	9	3.50	1.04	9	2.14	0.63
11	2.11	1.35	12	2.97	1.01	14	1.81	0.62

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 2

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	4.08	1.06	1	3.53	1.25	1	2.19	0.67
1	4.17	0.79	3	2.83	1.60	2	1.89	0.74
7	2.81	1.60	4	2.80	1.20	7	1.78	0.62
10	2.11	1.31	5	2.69	1.31	4.5	1.83	0.68
5	3.89	1.13	2	2.86	1.10	3	1.86	0.62
11	2.06	1.25	11	2.39	1.21	9.5	1.67	0.66
3.5	3.92	1.26	7	2.67	0.94	6	1.81	0.62
8	2.72	1.41	7	2.67	1.17	4.5	1.83	0.60
9	2.53	1.36	10	2.47	1.14	11	1.61	0.60
6	3.36	1.29	7	2.67	1.10	8	1.72	0.64
3.5	3.92	1.12	9	2.61	1.00	9.5	1.67	0.57

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 3

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

1	4.58	0.76	1	3.97	0.95	1	2.42	0.55
3	2.75	1.44	2	3.53	1.09	2	2.19	0.70
6	1.89	1.05	4.5	2.89	1.20	3	2.08	0.72
4	2.39	1.44	3	2.94	1.24	4	1.97	0.68
5	2.11	1.35	4.5	2.89	1.08	5.5	1.92	0.68
2	2.86	1.41	6	2.67	1.15	5.5	1.92	0.68

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 4

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.50	0.36	1	3.92	1.14	1	2.50	0.68
2	3.35	1.03	2	3.89	0.97	2	2.44	0.50
5	3.03	1.24	9.5	3.64	0.97	3	2.42	0.55
3	3.14	1.25	11	3.61	1.04	7.5	2.31	0.57
6	2.89	1.58	5.5	3.69	0.91	5.5	2.33	0.52
4	3.08	1.36	9.5	3.64	0.97	7.5	2.31	0.52
11	2.42	1.30	3.5	3.75	0.98	4	2.36	0.57
8	2.56	1.32	3.5	3.75	0.89	10	2.25	0.60
12	2.30	1.20	7.5	3.67	0.94	9	2.28	0.60
10	2.50	1.25	7.5	3.67	0.94	11	2.22	0.63
7	2.81	1.37	5.5	3.69	1.08	5.5	2.33	0.57
9	2.53	1.40	12	3.47	0.86	12	2.08	0.64

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 5

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.31	1.43	1	4.03	0.89	1	2.47	0.55
4	2.89	1.49	11	3.42	1.21	11.5	2.25	0.68
5	2.36	1.20	3	3.72	0.98	7.5	2.33	0.57
2.5	3.17	1.44	9.5	3.58	1.14	7.5	2.33	0.57
2.5	3.17	1.42	9.5	3.58	1.19	2	2.44	0.55
8	2.06	1.15	5.5	3.67	0.97	4.5	2.36	0.47
11	1.83	0.68	4	3.69	0.97	7.5	2.33	0.70
6	2.42	1.46	2	3.75	1.06	3	2.42	0.60
14	1.69	1.05	14	3.00	1.22	13	2.14	0.66
11	1.83	1.06	5.5	3.67	1.05	4.5	2.36	0.57
13	1.78	0.94	12	3.33	1.15	11.5	2.25	0.60
9	1.92	1.16	7	3.64	0.85	7.5	2.33	0.57
11	1.83	1.01	8	3.61	1.01	10	2.31	0.52
7	2.11	1.31	13	3.25	1.23	14	2.11	0.66

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 6

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
8	1.92	1.64	4.5	3.17	0.55	4	2.17	0.55
6	2.33	1.37	8	3.03	0.98	4	2.17	0.60
9	1.89	1.33	10	2.39	1.14	9.5	1.94	0.62
7	1.94	1.17	3	3.28	1.06	8	2.06	0.66
4	2.55	1.38	7	3.08	1.01	6	2.11	0.52
2	2.81	1.39	4.5	3.17	1.04	7	2.08	0.55
3	2.69	1.54	1	3.56	0.95	1	2.28	0.79
5	2.47	1.34	2	3.47	0.95	2	2.25	0.49
11	1.75	1.09	11	2.36	1.37	11	1.64	0.74
12	1.47	0.68	12	2.31	1.22	12	1.58	0.68
10	1.81	1.05	9	2.92	1.06	9.5	1.94	0.57
1	3.22	1.37	6	3.14	1.13	4	2.17	0.55

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 7

AC-DC Machinery

	Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Analyze the operation of DC generators.	6	2.17	1.44	5	3.14	1.26	2	2.14	0.66
Study and use the conventions for generators and motors.	2	2.42	1.40	1	3.36	0.70	2	2.14	0.66
Test the performance of different types of DC motors.	5	2.28	1.32	8	3.08	1.23	9	2.06	0.74
Analyze the operation of AC generators.	8.5	2.00	1.26	9	3.07	1.14	9	2.06	0.70
Set up and verify the load characteristics of a polyphase motor.	11	1.83	1.25	11.5	2.89	1.15	12	2.00	0.70
Verify the losses and efficiency of a motor by different methods.	12.5	1.75	1.16	10	3.06	1.15	6	2.08	0.72
Record the advantages and disadvantages of several types of single phase motors.	12.5	1.75	1.04	6.5	3.11	1.17	6	2.08	0.68
Set up and verify the operating characteristics of different types of synchros.	8.5	2.00	1.31	6.5	3.11	1.20	9	2.06	0.62
Verify the polarity and load performance of a transformer.	1	2.50	1.16	2.5	3.22	0.94	6	2.08	0.64
Verify the transformer losses and equivalent circuit.	4	2.31	1.43	2.5	3.22	1.05	4	2.11	0.88
Calculate transformer efficiency and voltage regulation.	3	2.39	1.32	4	3.17	1.09	2	2.14	0.63
Test the performance of different three phase connections.	7	2.11	1.35	11.5	2.89	1.10	11	2.03	0.72
Calculate the mechanical characteristics of a servo system.	10	1.92	1.30	13	2.78	1.13	13	1.89	0.74

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 8

Electronics Projects

Connect, evaluate and troubleshoot linear integrated circuits.

Identify integrated-circuit logic and memories.

Connect, evaluate and troubleshoot digital integrated circuit sub-systems.

Design, construct and troubleshoot electronic projects.

Use the guidelines of technical report writing to write project reports.

Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.

Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).

Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.

Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.

Connect and test A/D and D/A converters.

Connect and test the phase lock loop circuits.

Connect and analyze active filters and phase-shifters.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
3	3.59	1.35	2	3.34	1.13	4	2.11	0.70
2	3.81	1.41	1	3.36	1.31	2	2.14	0.64
4	3.64	1.61	4.5	3.19	1.39	6	1.97	0.79
6	3.25	1.58	3	3.28	1.25	2	2.14	0.70
11.5	2.42	1.16	7	3.00	1.35	7	1.92	0.72
5	3.36	1.41	4.5	3.19	1.26	2	2.14	0.74
1	4.06	1.15	6	3.03	1.40	5	2.00	0.84
9	2.92	1.40	11	2.53	1.25	11	1.72	0.79
7	3.19	1.49	9.5	2.64	1.15	10	1.81	0.69
8	3.00	1.41	9.5	2.64	1.39	9	1.86	0.78
11.5	2.42	1.44	12	2.28	1.14	12	1.67	0.66
10	2.47	1.40	8	2.81	1.08	8	1.89	0.56

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 9

Industrial Electronics

Construct solid state controls.

Calculate and test phase shift control circuits.

Set up and test a SCR with AC bias control.

Set up and test the response of photoelectric devices.

Set up and test the photoelectric control of a SCR.

Test different types of relay circuits.

Test different types of timing circuits.

Set and test delay relay circuit.

Use the UJT as a triggering device.

Graph curve of variable reluctance phase shift circuit.

Set up and test different motor control circuits.

Set up and test different servo systems.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
6	2.50	1.36	11	2.89	1.15	7	2.00	0.70
8	2.31	1.39	6.5	3.03	1.14	3	2.11	0.57
7	2.39	1.46	3	3.17	1.16	3	2.11	0.57
4	2.56	1.34	9.5	2.92	1.14	11	1.94	0.70
10	2.28	1.23	9.5	2.92	1.23	7	2.00	0.66
1	3.19	1.35	4	3.11	1.17	9.5	1.97	0.64
2	3.11	1.41	2	3.22	0.94	3	2.11	0.62
3	2.94	1.49	8	3.00	1.24	5	2.06	0.66
9	2.30	1.49	1	3.42	1.11	1	2.17	0.64
12	1.47	0.72	12	2.67	1.29	12	1.89	0.70
5	2.53	1.44	5	3.08	1.21	9.5	1.97	0.72
11	2.22	1.33	6.5	3.03	1.16	7	2.00	0.47

GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN

Table 10

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
5	3.58	1.64	2	3.17	1.40	3	2.11	0.81
11	2.97	1.60	1	3.53	1.28	1	2.19	0.74
3	4.14	1.29	3	3.14	1.24	4.5	2.08	0.68
4	3.78	1.58	9	2.67	1.37	10	1.81	0.78
6.5	3.42	1.69	13	2.36	1.26	12	1.69	0.74
9	3.11	1.76	4	3.11	0.84	8	1.83	0.83
6.5	3.42	1.74	5	3.06	1.47	6	1.97	0.76
10	3.06	1.73	8	2.75	1.50	10	1.81	0.78
8	3.19	1.63	12	2.42	1.38	13	1.58	0.72
12	2.94	1.68	10.5	2.61	1.42	10	1.81	0.81
13	2.92	1.65	14	2.17	1.23	14	1.53	0.68
2	4.19	1.39	6	3.03	1.25	2	2.17	0.83
14	2.56	1.48	10.5	2.61	1.21	7	1.89	0.66
1	4.47	1.06	7	2.78	1.20	4.5	2.08	0.68

Chapter IV

Graduates Working in a Related Field

It was felt that the graduates working in a related field should be separated from the graduates working as an Electronic Technician because of their different response to 'Importance on Job'. The related fields stated and the number in each are:

Designer - 5

Repairman - 4

Sales - 2

Field
Service - 2

Quality
Control - 1

Summary of responses from graduates working in a related field.
Refer to the criterion given in Chapter II:

Importance on Job
Least Importance

Mean	Table	Competency
1.43	16	Calculate and test frequency effects on amplifier performance.
1.64	16	Simplify circuits using decibels and Miller's theorem.
1.64	16	Find the harmonics present in a mixer.
1.64	19	Graph curve of variable reluctance phase shift circuit.
1.71	17	Set up and verify the characteristics of a polyphase motor.
1.71	11	Apply Thevins theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Note: No mean is below 1.40.

Most Importance

Mean	Table	Competency
4.43	13	Identify standard electronic symbols and diagrams.
4.00	14	Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.
3.93	12	Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.
3.92	11	Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Standard Deviation -- Table 20 shows the largest number of competencies with a large deviation. Seven competencies are between 1.60 and 1.81. This probably shows that some graduates work with computers and others don't. Note: No deviation is greater than 1.81.

For further comparison of graduates working in related field vs. graduates working in the field, see Chapter VII.

Preparation at School

Poorest Preparation

Mean	Table	Competency
2.33	20	Use control bus for external controllers.
2.36	20	Interface microprocessor with I/O.
2.36	20	Write, debug and run micro-computer programs.
2.50	20	Connect, test and troubleshoot computer memory circuits.
2.50	20	Describe the architecture of microprocessor and micro-computer.

Note: No mean is below 2.00.

Best Preparation

Mean	Table	Competency
4.86	11	Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.
4.76	11	Verify series and parallel circuit operation using Kirchoff's Law.
4.57	11	Identify the effects of capacitance and inductance in DC.
4.50	11	Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Standard Deviation -- All deviations are less than 1.55. This means that all of the graduates agree very well on their preparation at school.

Adequacy of Instructional Equipment

Poorest equipment

Mean	Table	Competency
1.50	18	Connect, evaluate and troubleshoot digital integrated circuit sub-systems.
1.71	16	Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.
1.71	19	Construct solid state controls.
1.71	19	Set up and test a SCR with AC bias control.
1.71	20	Interface microprocessor with I/O.
1.71	20	Write, debug and run micro-computer programs.

Best equipment

Mean	Table	Competency
2.64	14	Identify and use the basic controls of an oscilloscope and set up and display various electric wave forms.
2.57	11	Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.
2.57	11	Verify series and parallel circuit operation using Kirchoff's Law.

Standard Deviation -- There were two competencies with a deviation greater than 1.21.

Deviation	Table	Competency
1.83	13	Use standard abbreviations, component references, fasteners and military and engineering standards in electronics work.
1.80	18	Connect, evaluate and troubleshoot digital integrated circuit sub-system.

GRADUATES WORKING IN A RELATED FIELD

Table 11

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenin's theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.92	1.22	5.5	4.36	0.59	4.5	2.50	0.50
2	3.71	1.03	4	4.50	0.59	7.5	2.43	0.50
3	3.57	1.19	1	4.86	0.26	1.5	2.57	0.50
8	2.50	1.30	2	4.76	0.46	1.5	2.57	0.50
10	2.07	1.48	5.5	4.36	0.80	6	2.49	0.50
12.5	1.78	1.13	9.5	4.07	0.80	3	2.51	0.50
4	3.00	1.25	3	4.57	0.53	9	2.36	0.61
6	2.85	1.41	8	4.21	1.25	7.5	2.43	0.50
12.5	1.78	1.01	13	3.36	1.01	13	2.00	0.65
5	2.86	1.30	9.5	4.07	0.70	12.5	2.07	0.59
11	2.00	1.06	12	3.71	0.88	12.5	2.07	0.59
7	2.73	1.06	7	4.29	0.70	4.5	2.50	0.50
14	1.71	0.80	10.5	4.00	1.06	10.5	2.21	0.67
9	2.43	1.23	10.5	4.00	0.92	10.5	2.21	0.67

GRADUATES WORKING IN A RELATED FIELD

Table 12

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	3.79	1.20	1	4.07	1.07	1	2.31	0.72
1	3.93	1.48	2	3.77	1.12	2	2.15	0.77
7	2.64	1.48	8	3.23	1.30	9.5	1.85	0.77
8.5	2.50	1.50	9	3.21	1.51	7.5	1.86	0.74
3	3.64	1.53	3.5	3.43	1.33	4.5	2.00	0.75
11	2.14	1.13	11	2.79	1.19	9.5	1.85	0.74
4	3.43	1.23	3.5	3.43	1.03	4.5	2.00	0.75
8.5	2.50	0.98	6.5	3.29	1.22	6	1.93	0.95
10	2.43	1.18	10	3.07	1.16	7.5	1.86	0.74
5.5	3.07	1.16	6.5	3.29	1.03	11	1.79	0.67
5.5	3.07	1.16	5	3.42	1.17	3	2.07	0.70

GRADUATES WORKING IN A RELATED FIELD

Table 13

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

1	4.43	0.90	1	4.33	0.60	1	2.43	0.49
3	3.21	1.82	2	3.71	0.70	2.5	2.29	1.03
6	2.43	1.10	6	3.14	1.00	4.5	2.14	0.63
4	3.20	1.53	3	3.57	0.82	4.5	2.14	0.74
2	3.22	0.87	4	3.43	0.97	2.5	2.29	0.69
5	3.07	1.58	5	3.21	0.84	6	2.07	1.83

GRADUATES WORKING IN A RELATED FIELD

Table 14

Principles of Alternating Current

	Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.	1	4.00	1.00	2	4.29	0.88	1.5	2.64	0.47
Define the characteristics of AC currents and voltages.	2	3.57	0.65	3.5	4.21	0.67	1.5	2.64	0.47
Calculate the effect of capacitance in an AC circuit.	3	3.00	1.25	1	4.36	0.70	5	2.50	0.50
Verify the effect of capacitance in an AC circuit.	4	3.14	1.46	3.5	4.21	0.67	5	2.50	0.50
Calculate the effect of inductance in an AC circuit.	5	2.86	1.46	5	4.20	0.77	5	2.50	0.50
Verify the effect of inductance in an AC circuit.	6	2.71	1.38	6	4.07	0.80	5	2.50	0.50
Calculate the impedance, phase angle, power and voltage in series circuits.	8	2.21	0.67	7	3.86	0.92	5	2.50	0.50
Measure the impedance, phase angle, power and voltage in series circuits.	10	2.00	1.00	8.5	3.71	1.16	10.5	2.29	0.80
Calculate the impedance, phase angle, power and current in parallel circuits.	10	2.00	1.00	8.5	3.71	0.96	8.5	2.43	1.04
Measure the impedance, phase angle, power and current in parallel circuits.	10	2.00	1.00	11.5	3.64	1.10	10.5	2.29	0.70
Solve problems involving AC networks.	7	2.43	1.17	11.5	3.64	0.96	12	2.21	0.67
Solve problems involving three phase systems.	12	1.93	1.38	10	3.70	0.88	8.5	2.43	1.04

GRADUATES WORKING IN A RELATED FIELD

Table 15

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1.5	3.14	1.25	1.5	4.07	1.22	3	2.50	0.50
3.5	3.00	1.19	9.5	3.64	0.96	10.5	2.36	0.47
6	2.71	1.48	5	3.86	0.75	6	2.43	0.49
3.5	3.00	1.19	6.5	3.79	0.77	6	2.43	0.49
5	2.93	1.48	3.5	4.00	0.84	6	2.43	0.62
8.5	2.50	1.54	6.5	3.79	0.92	10.5	2.36	0.59
8.5	2.50	1.45	3.5	4.00	0.92	2	2.51	0.50
10	2.36	1.33	1.5	4.07	0.96	4	2.49	0.62
13	2.07	1.10	8	3.71	1.10	8.5	2.37	0.70
12	2.14	1.30	9.5	3.64	0.96	1	2.52	0.62
1.5	3.14	0.53	12.5	3.43	1.03	12.5	2.35	0.70
14	1.93	1.16	12.5	3.43	1.48	8.5	2.37	0.70
11	2.21	1.26	11	3.50	0.90	12.5	2.35	0.47
7	2.57	1.50	14	3.21	1.01	14	2.29	0.70

GRADUATES WORKING IN A RELATED FIELD

Table 16

Electronic Circuits

	Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.	6.5	2.07	1.28	2.5	3.64	1.04	2	2.43	0.72
Construct, analyze and troubleshoot the field-effect transistor amplifier.	6.5	2.07	1.28	6.5	3.50	1.05	6	2.36	0.71
Simplify circuits using decibels and Miller's theorem.	10.5	1.64	0.89	11	2.93	1.53	10	2.14	0.83
Calculate and test frequency effects on amplifier performance.	12	1.43	0.81	9.5	3.07	1.33	6	2.36	0.60
Construct, analyze and troubleshoot differential amplifier circuits.	4	2.28	1.22	6.5	3.50	1.11	6	2.36	0.60
Construct, analyze and troubleshoot operational amplifier circuits.	2	2.43	1.17	2.5	3.64	1.04	2	2.43	0.62
Apply the principles of feedback to amplifiers.	3	2.36	1.38	2.5	3.64	0.88	2	2.43	0.50
Apply the principles of feedback to oscillators.	5	2.14	1.24	2.5	3.64	0.80	4	2.37	0.47
Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.	8	1.93	1.22	12	2.64	1.22	12	1.71	0.80
Find the harmonics present in a mixer.	10.5	1.64	0.89	9.5	3.07	1.22	11	2.07	0.70
Calculate and test the effects of modulation.	9	1.71	0.70	8	3.43	1.11	8	2.29	0.59
Construct, analyze and troubleshoot voltage regulators.	1	2.67	1.29	5	3.57	0.82	9	2.21	0.56

GRADUATES WORKING IN A RELATED FIELD

Table 17

AC-DC Machinery

Analyze the operation of DC generators.

Study and use the conventions for generators and motors.

Test the performance of different types of DC motors.

Analyze the operation of AC generators.

Set up and verify the load characteristics of a polyphase motor.

24. Verify the losses and efficiency of a motor by different methods.

Record the advantages and disadvantages of several types of single phase motors.

Set up and verify the operating characteristics of different types of synchros.

Verify the polarity and load performance of a transformer.

Verify the transformer losses and equivalent circuit.

Calculate transformer efficiency and voltage regulation.

Test the performance of different three phase connections.

Calculate the mechanical characteristics of a servo system.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
8	2.00	0.92	2.5	3.57	1.05	1.5	2.21	0.77
4	2.21	1.01	2.5	3.57	0.98	5.5	2.07	0.70
1.5	2.50	1.23	8	3.21	1.08	5.5	2.07	0.70
5	2.14	1.05	6.5	3.29	1.10	5.5	2.07	0.70
13	1.71	0.96	12.5	2.79	1.08	13	1.86	0.63
9.5	1.93	1.10	10	3.07	1.22	9.5	2.00	0.75
6	2.07	1.16	6.5	3.29	1.03	12	1.93	0.70
9.5	1.93	0.88	9	3.14	1.13	9.5	2.00	0.65
1.5	2.50	1.11	1	3.64	0.72	3	2.14	0.63
7	2.04	0.81	5	3.36	0.96	5.5	2.07	0.59
3	2.29	1.22	4	3.50	0.98	1.5	2.21	0.67
12	1.79	0.94	11	2.93	1.10	9.5	2.00	0.65
11	1.86	0.82	12.5	2.79	1.14	9.5	2.00	0.75

GRADUATES WORKING IN A RELATED FIELD

Table 18

Electronics Projects

	Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Connect, evaluate and troubleshoot linear integrated circuits.	6.5	3.00	1.46	7	3.29	1.33	7.0	2.00	0.84
Identify integrated-circuit logic and memories.	3	3.36	1.28	5.5	3.36	1.16	4.0	2.07	0.80
Connect, evaluate and troubleshoot digital integrated circuit sub-systems.	6.5	3.00	1.60	8	3.14	1.41	12	1.50	1.80
Design, construct and troubleshoot electronic projects.	10	2.64	1.48	3.0	3.57	0.94	2	2.28	0.70
Use the guidelines of technical report writing to write project reports.	4	3.21	1.30	1	3.79	0.92	1	2.43	0.62
Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.	2	3.43	1.34	3.0	3.57	0.98	7.0	2.00	0.75
Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).	1	3.57	1.32	3.0	3.57	1.18	7.0	2.00	0.75
5 Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.	8.5	2.86	1.06	10	2.93	1.16	9.5	1.86	0.83
Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.	8.5	2.86	1.51	11	2.86	1.19	11	1.78	0.67
Connect and test A/D and D/A converters.	5	3.07	1.53	5.5	3.36	1.16	4.0	2.07	0.70
Connect and test the phase lock loop circuits.	12	2.43	1.34	12	2.71	0.88	9.5	1.86	0.63
Connect and analyze active filters and phase-shifters.	11	2.50	1.34	9	3.07	0.59	4.0	2.07	0.46

GRADUATES WORKING IN A RELATED FIELD

Table 19

Industrial Electronics

Construct solid state controls.

Calculate and test phase shift control circuits.

Set up and test a SCR with AC bias control.

Set up and test the response of photoelectric devices.

Set up and test the photoelectric control of a SCR.

Test different types of relay circuits.

Test different types of timing circuits.

Set and test delay relay circuit.

Use the UJT as a triggering device.

Graph curve of variable reluctance phase shift circuit.

Set up and test different motor control circuits.

Set up and test different servo systems.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
5	2.50	1.54	9	2.86	1.30	11.5	1.71	0.70
11	1.93	1.10	7.0	2.93	1.16	7.5	1.79	0.67
6	2.36	1.10	5	3.07	1.16	11.5	1.71	0.70
4	2.64	1.38	7.0	2.93	1.10	7.5	1.79	0.86
7.5	2.29	1.28	7.0	2.93	1.10	5	1.92	0.73
1	3.14	0.70	3	3.36	0.80	3.5	2.00	0.67
2	3.07	1.58	2	3.43	0.73	1.5	2.08	0.62
3	2.93	1.43	4	3.29	0.80	1.5	2.08	0.62
9.5	2.21	1.26	1	3.46	0.80	3.5	2.00	0.55
12	1.64	0.88	11.0	2.85	1.24	6	1.85	1.10
7.5	2.29	0.88	11.0	2.85	0.96	9.5	1.77	0.69
9.5	2.21	1.26	11.0	2.85	1.10	9.5	1.77	0.69

GRADUATES WORKING IN A RELATED FIELD

Table 20

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

Importance on Job			Preparation at School			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
3	3.57	1.21	6.5	2.86	1.13	7	2.00	0.65
10.5	3.14	1.64	1	3.21	1.30	3	2.14	0.63
10.5	3.14	1.51	5	2.93	0.96	2	2.21	0.77
12.5	3.00	1.55	8	2.64	1.10	9.0	1.93	0.70
14	2.93	1.66	10.5	2.50	1.18	9.0	1.93	0.70
7	3.31	1.64	6.5	2.86	1.05	5.0	2.07	0.59
8	3.21	1.64	9	2.57	1.11	9.0	1.93	0.70
12.5	3.00	1.64	10.5	2.50	1.23	12	1.79	0.77
6	3.36	1.73	12.5	2.36	1.17	13.5	1.71	0.70
4	3.43	1.58	12.5	2.36	1.16	13.5	1.71	0.70
9	3.20	1.69	14	2.33	1.19	11	1.80	0.74
1	3.79	0.92	3	3.13	0.89	5.0	2.07	0.68
5	3.40	1.54	4	3.00	0.96	5.0	2.07	0.68
2	3.60	1.36	2	3.20	0.65	1	2.27	0.57

Chapter V

Employers of Electronic Technicians

Permission to contact employers was received from 22 graduates. First the employer was called to see if he or she would take part in the survey. Then the survey was sent. If there was no response, in about a week a follow up call was made. Some said the instrument was too long but did state that "the graduates from Wisconsin Technical Institutes were very good". Some employers were on vacation and had to be called again. Eventually, 15 responses were received.

Employers are requested to complete the same competency list given to graduates, and were to rate each competency according to Importance on Job and Preparation at School. A copy of the employer survey instrument may be found in Appendix E.

Summary of responses from employers. Refer to the criterion given in Chapter II:

Importance on Job

Least Importance

Mean	Table	Competency
1.73	27	Set up and verify the operating characteristics of different types of synchros.
1.92	26	Analyze the amplifier distortion with the distortion analyzer of spectrum analyzer.
1.93	27	Calculate the mechanical characteristics of a servo system.
1.93	29	Graph curve of variable reluctance phase shift circuit.
1.93	21	Design different meters using a DC meter movement.

Note: No mean is below 1.40.

Most Importance

Mean	Table	Competency
4.93	23	Prepare electronic schematic.
4.87	22	Identify and practice safety procedures in the laboratory.
4.67	24	Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.
4.53	21	Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Standard Deviation -- One deviation met the criterion and some others were close.

Deviation	Table	Competency
1.81	29	Construct solid state controls.
1.79	30	Identify the functions and applications of a digital computer.
1.77	29	Set up and test different motor control circuits.
1.71	29	Set up and test different servo systems.
1.70	21	Describe the properties of permanent magnetism and electromagnetism.

Preparation at School

Poorest Preparation

Mean	Table	Competency
2.00	27	Test the performance of different types of DC motors.
2.00	27	Analyze the operation of AC generators.
2.00	27	Verify the losses and efficiency of a motor by different methods.
2.00	27	Set up and verify the operating characteristics of different types of synchros.

Note: No mean is below 2.00.

Best Preparation

Mean	Table	Competency
4.28	21	Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.
4.17	21	Calculate and verify unknown voltage, current, resistance, or power in simple circuits using Ohm's Law.
4.11	21	Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Best Preparation (continued)

Mean	Table	Competency
4.00	21	Design different meters using a DC meter movement.
4.00	23	Identify standard electronic symbols and diagrams.

Standard Deviation -- All deviations are less than 1.42. This means that the employers agree very well on the graduates preparation at school.

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 21

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenin's theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	4.47	0.73	1	4.28	0.74
1	4.53	0.89	3	4.11	1.00
3	4.27	0.85	2	4.17	0.91
5	3.53	1.21	10	3.31	0.62
6	3.47	0.89	7	3.50	0.76
14	1.93	1.00	4	4.00	0.40
7	3.40	1.15	8	3.42	0.76
4	3.67	1.39	6	3.54	0.73
10	2.40	1.19	9	3.33	0.66
11.5	2.33	1.70	12.5	3.00	0.00
13	2.07	1.12	14	2.80	0.16
8	2.87	1.46	5	3.64	0.79
11.5	2.33	1.35	11	3.12	0.74
9	2.53	1.36	12.5	3.00	0.47

EMPLOYERS OF ELECTRONIC TECHNICIANS

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.87	0.50	4	3.43	1.23
3	4.30	1.52	3	3.64	1.10
7	2.60	1.41	7	3.27	0.86
9.5	2.33	1.53	8	3.22	0.39
2	4.33	0.79	1	3.85	0.77
11	2.13	1.40	10	3.10	0.70
4.5	4.20	1.10	2	3.71	0.96
9.5	2.33	1.07	10	3.10	0.53
8	2.53	1.21	10	3.10	0.53
4.5	4.20	1.16	5.5	3.38	0.62
6	3.93	1.29	5.5	3.38	0.62

Table 22

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

Table 23

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

2	4.47	1.00	1	4.00	0.75
1	4.93	0.85	2	3.27	0.44
6	2.13	1.30	6	2.78	0.42
3	2.87	1.26	4	3.00	0.00
5	2.27	1.29	5	2.89	0.31
4	2.67	1.18	3	3.18	0.71

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 24

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.67	0.64	1	3.50	0.90
2	3.73	0.89	2	3.21	0.56
10	2.67	1.13	12	2.93	0.28
10	2.67	1.24	7.5	3.00	0.00
6.5	2.75	1.19	7.5	3.00	0.00
6.5	2.75	1.34	7.5	3.00	0.00
8	2.69	1.35	7.5	3.00	0.00
4	2.81	1.33	7.5	3.00	0.00
12	2.60	1.30	7.5	3.00	0.00
3	2.93	1.39	3	3.17	0.57
5	2.80	1.32	7.5	3.00	0.00
10	2.67	1.01	7.5	3.00	0.91

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 25

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
5	3.20	1.32	5	3.17	0.81
1	3.47	1.36	3	3.33	0.74
2	3.33	1.19	4	3.20	0.60
3.5	3.27	1.61	1.5	3.36	0.64
3.5	3.27	1.61	1.5	3.36	0.63
9	2.43	1.39	6.5	3.10	0.30
6.5	2.67	1.57	6.5	3.10	0.30
6.5	2.67	1.52	13	2.91	0.28
13	2.21	1.25	14	2.90	0.30
12	2.27	1.29	10	3.00	0.00
10.5	2.40	1.40	10	3.00	0.00
14	2.20	1.33	10	3.00	0.00
10.5	2.40	1.20	10	3.00	0.00
5	2.47	1.20	10	3.00	0.00

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 26

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
4	2.33	1.00	2	3.22	0.63
7	2.27	1.34	2	3.22	0.63
10	2.13	1.25	5	3.13	0.33
9	2.23	1.30	9.5	3.00	0.00
7	2.27	1.48	9.5	3.00	0.47
7	2.27	1.61	2	3.22	0.42
2	2.64	1.43	6	3.10	0.31
3	2.43	1.29	9.5	3.00	0.00
12	1.92	0.88	9.5	3.00	0.00
11	2.00	0.92	9.5	3.00	0.00
5	2.29	0.88	9.5	3.00	0.00
1	3.14	1.41	4	3.17	0.57

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 27

AC-DC Machinery

Analyze the operation of DC generators.

Study and use the conventions for generators and motors.

Test the performance of different types of DC motors.

Analyze the operation of AC generators.

Set up and verify the load characteristics of a polyphase motor.

Verify the losses and efficiency of a motor by different methods.

Record the advantages and disadvantages of several types of single phase motors.

Set up and verify the operating characteristics of different types of synchros.

Verify the polarity and load performance of a transformer.

Verify the transformer losses and equivalent circuit.

Calculate transformer efficiency and voltage regulation.

Test the performance of different three phase connections.

Calculate the mechanical characteristics of a servo system.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
10.5	2.00	1.21	1.5	3.00	0.00
3	2.27	1.22	1.5	3.00	0.00
8	2.06	0.96	11.5	2.00	0.00
10.5	2.00	0.86	11.5	2.00	0.00
8	2.06	0.75	4	2.90	0.30
8	2.06	0.90	11.5	2.00	0.00
6	2.07	1.18	7.5	2.89	0.33
13	1.73	0.85	11.5	2.00	0.00
1.5	2.87	1.26	4	2.90	0.30
1.5	2.87	1.26	7.5	2.89	0.31
4.5	2.13	1.08	7.5	2.89	0.31
4.5	2.13	1.08	4	2.90	0.30
12	1.93	1.00	7.5	2.89	0.31

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 28

Electronics Projects

Connect, evaluate and troubleshoot linear integrated circuits.
Identify integrated-circuit logic and memories.
Connect, evaluate and troubleshoot digital integrated circuit sub-systems.
Design, construct and troubleshoot electronic projects.
Use the guidelines of technical report writing to write project reports.
Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.
Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).
Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.
Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.
Connect and test A/D and D/A converters.
Connect and test the phase lock loop circuits.
Connect and analyze active filters and phase-shifters.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
5	3.40	1.30	3	3.50	0.95
3	4.07	1.18	2	3.54	0.87
2	4.20	0.83	1	3.64	0.98
9	3.07	1.43	8.5	3.00	0.42
6	3.20	1.60	12	2.50	0.64
8	3.11	1.46	6	3.33	0.64
1	4.40	0.73	4.5	3.36	1.03
7	3.13	0.89	8.5	3.00	0.87
4	3.71	1.13	4.5	3.36	0.60
10	2.93	1.58	8.5	3.00	0.40
12	2.63	1.32	8.5	3.00	0.40
11	2.67	1.43	11	2.91	0.28

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 29

Industrial Electronics

Construct solid state controls.

Calculate and test phase shift control circuits.

Set up and test a SCR with AC bias control.

Set up and test the response of photoelectric devices.

Set up and test the photoelectric control of a SCR.

Test different types of relay circuits.

Test different types of timing circuits.

Set and test delay relay circuit.

Use the UJT as a triggering device.

Graph curve of variable reluctance phase shift circuit.

Set up and test different motor control circuits.

Set up and test different servo systems.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
6	2.86	1.81	8.5	3.00	0.33
11	2.21	1.14	12	2.78	0.42
9.5	2.43	1.50	8.5	3.00	0.33
5	2.93	1.66	6	3.10	0.30
9.5	2.43	1.50	3	3.30	1.41
2	3.79	1.36	1	3.50	0.76
1	3.93	1.38	2	3.33	0.86
3	3.21	1.69	4	3.27	0.60
4	3.00	0.75	8.5	3.00	0.00
12	1.93	1.22	11	2.89	0.33
7	2.79	1.77	5	3.20	0.74
8	2.57	1.71	8.5	3.00	0.77

EMPLOYERS OF ELECTRONIC TECHNICIANS

Table 30

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

Importance on Job			Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
6	3.93	1.79	8	3.33	1.11
12.5	3.20	1.41	4.5	3.42	0.95
2	4.20	1.10	2	3.46	1.15
4.5	4.00	1.36	4.5	3.42	0.95
7	3.87	1.41	13	3.08	1.08
8	3.80	1.32	11	3.25	0.83
9	3.60	1.45	3	3.45	1.08
14	3.13	1.50	6	3.40	1.01
10	3.40	0.70	9.5	3.27	1.05
12.5	3.20	1.32	12	3.18	0.93
11	3.27	1.43	14	3.00	0.73
2	4.20	1.16	1	3.50	1.04
4.5	4.00	1.36	7	3.36	0.79
2	4.20	1.37	9.5	3.27	0.96

Chapter VI

Comparison of Graduate and Employer Response

In an effort to determine the degree of agreement between Electronic Technology graduates working as Electronic Technicians and employers, a comparison of responses was made. It was felt that this would indicate the areas where the two groups disagree and agree about the Importance on Job and Preparation at School. This information can be used by each school to review the competencies taught in their Electronic Technology program.

Tables 31-40 compare competency by rank, mean and standard deviation for Importance on Job. Tables 41-50 compare competency by rank, mean and standard deviation for Preparation at School.

Summary of Comparisons of Importance on Job

Of the 120 competencies, the graduates had a higher mean on 28 of them, the employers had a higher mean on 88 of them and the graduates and employers had the same mean on four of the competencies.

Following is a list of the 12 competencies with the highest difference of mean, who had the highest mean, table where found and the competency. Since Importance on Job was rated from 1 (no knowledge necessary) to 5 (knowledge essential) a difference in mean of 0.70 or greater may be considered important.

<u>Difference in Mean</u>	<u>Higher Mean</u>	<u>Table</u>	<u>Competency</u>
2.18	Employer	33	Prepare electronic schematic.
1.44	Employer	40	Use test equipment to calibrate electronic equipment.
1.25	Employer	31	Calculate and verify series-parallel circuits using network theorems.
1.11	Employer	31	Verify series and parallel circuit operation using Kirchoff's Law.
0.84	Employer	35	Calculate and measure the input impedance and output impedance of a given transistor amplifier.
0.84	Employer	32	Select proper hook-up wires and inter-connection techniques.
0.82	Employer	39	Test different types of timing circuits.
0.79	Employer	32	Identify and practice safety procedures in the laboratory.
0.78	Employer	38	Use the guidelines of technical report writing to write project reports.
0.71	Employer	31	Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.
0.70	Employer	31	Apply voltage divider rule and current divider rule to circuit analysis.
0.70	Employer	39	Use the UJT as a triggering device.

Summary of Comparisons of Preparation at School

Of the 120 competencies, the graduates had a higher mean on 58 of them, the employers had a higher mean on 60 of them and the graduates and employers had the same mean on two of the competencies.

Following is a list of the 12 competencies with the highest difference of mean, who had the highest mean, table where found and the competency. Since Preparation at School was rated from 1 (unprepared) to 5 (excellent preparation) a difference in mean of 0.80 or greater may be considered important.

<u>Difference in Mean</u>	<u>Higher Mean</u>	<u>Table</u>	<u>Competency</u>
1.11	Graduate	47	Set up and verify the operating characteristics of different types of synchros.
1.08	Graduate	47	Test the performance of different types of DC motors.
1.07	Graduate	47	Analysis of the operation of AC generators.
1.06	Graduate	47	Verify the losses and efficiency of a motor by different methods.
1.04	Employer	42	Solder and desolder printed circuit boards, interconnection wires.
0.99	Employer	42	Select and use hand tools and hardware for electrical assembly.
0.92	Employer	41	Design different meters using a DC meter movement.
0.86	Graduate	45	Identify the characteristics of semi-conductors and properties of PN junction.
0.85	Employer	50	Interface microprocessor with I/O.
0.84	Graduate	45	Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.
0.83	Employer	50	Use control bus for external controllers.
0.81	Employer	42	Mount and connect electrical components by soldering, splicing, cabling, bread-boarding and wire-wrapping.

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 31

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenin's theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Graduate Importance on Job			Employer Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.47	0.80	2	4.47	0.73
2	4.06	0.91	1	4.53	0.89
3	3.56	1.04	3	4.27	0.85
8	2.42	1.01	5	3.53	1.21
10	2.22	1.17	6	3.47	0.89
14	1.47	1.01	14	1.93	1.00
5	2.72	1.02	7	3.40	1.15
4	2.97	1.30	4	3.67	1.39
7	2.44	0.64	10	2.40	1.19
9	2.33	1.39	11.5	2.33	1.70
13	1.72	1.09	13	2.07	1.12
6	2.61	1.30	8	2.87	1.46
12	1.97	1.16	11.5	2.33	1.35
11	2.11	1.35	9	2.53	1.36

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 32

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

Graduate Importance on Job			Employer Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	4.08	1.06	1	4.87	0.50
1	4.17	0.79	3	4.30	1.52
7	2.81	1.60	7	2.60	1.41
10	2.11	1.31	9.5	2.33	1.53
5	3.89	1.13	2	4.33	0.79
11	2.06	1.25	11	2.13	1.40
3.5	3.92	1.26	4.5	4.20	1.10
8	2.72	1.41	9.5	2.33	1.07
9	2.53	1.36	8	2.53	1.21
6	3.36	1.29	4.5	4.20	1.16
3.5	3.92	1.12	6	3.93	1.29

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 33

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

1	4.58	0.76	2	4.47	1.00
3	2.75	1.44	1	4.93	0.85
6	1.86	1.05	6	2.13	1.30
4	2.39	1.44	3	2.87	1.26
5	2.11	1.35	5	2.27	1.29
2	2.86	1.41	4	2.67	1.18

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 34

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

Graduate Importance on Job			Employer Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.50	0.86	1	4.67	0.64
2	3.86	1.03	2	3.73	0.89
5	3.03	1.24	10	2.67	1.13
3	3.14	1.25	10	2.67	1.24
6	2.89	1.58	6.5	2.75	1.19
4	3.08	1.36	6.5	2.75	1.34
11	2.42	1.30	8	2.69	1.35
8	2.56	1.32	4	2.81	1.38
12	2.30	1.20	12	2.60	1.30
10	2.50	1.25	3	2.93	1.39
7	2.81	1.37	5	2.80	1.32
9	2.53	1.40	10	2.67	1.01

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 35

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

Graduate Importance on Job			Employer Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.31	1.43	5	3.20	1.32
4	2.89	1.49	1	3.47	1.36
5	2.86	1.20	2	3.33	1.19
2.5	3.17	1.44	3.5	3.27	1.61
2.5	3.17	1.42	3.5	3.27	1.61
8	2.06	1.15	9	2.43	1.39
11	1.83	0.68	6.5	2.67	1.57
6	2.42	1.46	6.5	2.67	1.52
14	1.69	1.05	13	2.21	1.25
11	1.83	1.06	12	2.27	1.29
13	1.78	0.94	10.5	2.40	1.40
9	1.92	1.16	14	2.20	1.33
11	1.83	1.01	10.5	2.40	1.20
7	2.11	1.31	8	2.47	1.20

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 36

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

Graduate Importance on Job			Employer Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
8	1.92	1.64	4	2.33	1.00
6	2.33	1.37	7	2.27	1.34
9	1.89	1.33	10	2.13	1.25
7	1.94	1.17	9	2.23	1.30
4	2.55	1.38	7	2.27	1.48
2	2.81	1.39	7	2.27	1.61
3	2.69	1.54	2	2.64	1.43
5	2.47	1.34	3	2.43	1.29
11	1.75	1.09	12	1.92	0.88
12	1.47	0.68	11	2.00	0.92
10	1.81	1.05	5	2.29	0.88
1	3.22	1.37	1	3.14	1.41

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 37

AC-DC Machinery

	Graduate Importance on Job			Employer Importance on Job		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Analyze the operation of DC generators.	6	2.17	1.44	10.5	2.00	1.21
Study and use the conventions for generators and motors.	2	2.42	1.40	3	2.27	1.22
Test the performance of different types of DC motors.	5	2.28	1.32	8	2.06	0.96
Analyze the operation of AC generators.	8.5	2.00	1.26	10.5	2.00	0.86
Set up and verify the load characteristics of a polyphase motor.	11	1.83	1.25	8	2.06	0.75
Verify the losses and efficiency of a motor by different methods.	12.5	1.75	1.16	8	2.06	0.90
Record the advantages and disadvantages of several types of single phase motors.	12.5	1.75	1.04	6	2.07	1.18
Set up and verify the operating characteristics of different types of synchros.	8.5	2.00	1.31	13	1.73	0.85
Verify the polarity and load performance of a transformer.	1	2.50	1.16	1.5	2.87	1.26
Verify the transformer losses and equivalent circuit.	4	2.31	1.43	1.5	2.87	1.26
Calculate transformer efficiency and voltage regulation.	3	2.39	1.32	4.5	2.13	1.08
Test the performance of different three phase connections.	7	2.11	1.35	4.5	2.13	1.08
Calculate the mechanical characteristics of a servo system.	10	1.92	1.30	12	1.93	1.00

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 38

Electronics Projects

	Graduate Importance on Job			Employer Importance on Job		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Connect, evaluate and troubleshoot linear integrated circuits.	3	3.69	1.35	5	3.40	1.30
Identify integrated-circuit logic and memories.	2	3.81	1.41	3	4.07	1.18
Connect, evaluate and troubleshoot digital integrated circuit sub-systems.	4	3.64	1.61	2	4.20	0.83
Design, construct and troubleshoot electronic projects.	6	3.25	1.58	9	3.07	1.43
Use the guidelines of technical report writing to write project reports.	11.5	2.42	1.16	6	3.20	1.60
Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.	5	3.36	1.41	8	3.11	1.46
Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).	1	4.06	1.15	1	4.40	0.73
Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.	9	2.92	1.40	7	3.13	0.89
Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.	7	3.19	1.49	4	3.71	1.18
Connect and test A/D and D/A converters.	8	3.00	1.41	10	2.93	1.58
Connect and test the phase lock loop circuits.	11.5	2.42	1.44	12	2.63	1.32
Connect and analyze active filters and phase-shifters.	10	2.47	1.40	11	2.67	1.43

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 39

Industrial Electronics

	Graduate Importance on Job			Employer Importance on Job		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Construct solid state controls.	6	2.50	1.36	6	2.86	1.81
Calculate and test phase shift control circuits.	8	2.31	1.39	11	2.21	1.14
Set up and test a SCR with AC bias control.	7	2.39	1.46	9.5	2.43	1.50
Set up and test the response of photoelectric devices.	4	2.56	1.34	5	2.93	1.66
Set up and test the photoelectric control of a SCR.	10	2.28	1.23	9.5	2.43	1.50
Test different types of relay circuits.	1	3.19	1.35	2	3.79	1.36
Test different types of timing circuits.	2	3.11	1.41	1	3.93	1.38
Set and test delay relay circuit.	3	2.94	1.49	3	3.21	1.69
Use the UJT as a triggering device.	9	2.30	1.49	4	3.00	0.75
Graph curve of variable reluctance phase shift circuit.	12	1.47	0.72	12	1.93	1.22
Set up and test different motor control circuits.	5	2.53	1.44	7	2.79	1.77
Set up and test different servo systems.	11	2.22	1.33	8	2.57	1.71

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 40

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

Graduate Importance on Job			Employer Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
5	3.58	1.64	6	3.93	1.79
11	2.97	1.60	12.5	3.20	1.41
3	4.14	1.29	2	4.20	1.10
4	3.78	1.58	4.5	4.00	1.36
6.5	3.42	1.69	7	3.87	1.41
9	3.11	1.76	9	3.80	1.32
6.5	3.42	1.74	9	3.60	1.45
10	3.06	1.73	14	3.13	1.50
8	3.19	1.63	10	3.40	0.70
12	2.94	1.68	12.5	3.20	1.32
13	2.92	1.65	11	3.27	1.43
2	4.19	1.39	2	4.20	1.16
14	2.56	1.48	4.5	4.00	1.36
1	4.47	1.06	2	4.20	1.37

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYER RESPONSE

Table 41

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenin's theorem, Norton's theorem, Delta-Wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2.5	4.11	0.88	1	4.28	0.74
2.5	4.11	0.91	3	4.11	1.00
1	4.33	0.83	2	4.17	0.91
4	4.00	0.85	10	3.31	0.62
6	3.75	0.95	7	3.50	0.76
10	3.08	1.21	4	4.00	0.40
8	3.61	0.86	8	3.42	0.76
5	3.94	0.91	6	3.54	0.73
13	2.75	1.04	9	3.33	0.66
14	2.28	0.95	12.5	3.00	0.00
11	3.00	0.91	14	2.80	0.16
7	3.72	0.95	5	3.64	0.79
9	3.50	1.04	11	3.12	0.74
12	2.97	1.01	12.5	3.00	0.47

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYER RESPONSE

Table 42

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.53	1.25	4	3.43	1.23
3	2.83	1.60	3	3.64	1.10
4	2.80	1.20	7	3.27	0.86
5	2.69	1.31	8	3.22	0.39
2	2.86	1.10	1	3.85	0.77
11	2.39	1.21	10	3.10	0.70
7	2.67	0.94	2	3.71	0.96
7	2.67	1.17	10	3.10	0.53
10	2.47	1.14	10	3.10	0.53
7	2.67	1.10	5.5	3.38	0.62
9	2.61	1.00	5.5	3.38	0.62

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYER RESPONSE

Table 43

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

1	3.97	0.95	1	4.00	0.75
2	3.53	1.09	2	3.27	0.44
4.5	2.89	1.20	6	2.78	0.42
3	2.94	1.24	4	3.00	0.00
4.5	2.89	1.08	5	2.89	0.31
6	2.67	1.15	3	3.18	0.71

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYER RESPONSE

Table 44

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.92	1.14	1	3.50	0.90
2	3.89	0.97	2	3.21	0.56
9.5	3.64	0.97	12	2.93	0.28
11	3.61	1.04	7.5	3.00	0.00
5.5	3.69	0.91	7.5	3.00	0.00
9.5	3.64	0.97	7.5	3.00	0.00
3.5	3.75	0.98	7.5	3.00	0.00
3.5	3.75	0.80	7.5	3.00	0.00
7.5	3.67	0.94	7.5	3.00	0.00
7.5	3.67	0.94	3	3.17	0.57
5.5	3.69	1.08	7.5	3.00	0.00
12	3.47	0.86	7.5	3.00	0.91

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYER RESPONSE

Table 45

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.03	0.89	5	3.17	0.81
11	3.42	1.21	3	3.33	0.74
3	3.72	0.98	4	3.20	0.60
9.5	3.58	1.14	1.5	3.36	0.64
9.5	3.58	1.19	1.5	3.36	0.63
5.5	3.67	0.97	6.5	3.10	0.30
4	3.69	0.97	6.5	3.10	0.30
2	3.75	1.06	13	2.91	0.28
14	3.00	1.22	14	2.90	0.30
5.5	3.67	1.05	10	3.00	0.00
12	3.33	1.15	10	3.00	0.00
7	3.64	0.85	10	3.00	0.00
8	3.61	1.01	10	3.00	0.00
13	3.25	1.23	10	3.00	0.00

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYER RESPONSE

Table 46

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
4.5	3.17	0.55	2	3.22	0.63
8	3.03	0.98	2	3.22	0.63
10	2.39	1.14	5	3.13	0.33
3	3.28	1.06	9.5	3.00	0.00
7	3.08	1.01	9.5	3.00	0.47
4.5	3.17	1.04	2	3.22	0.42
1	3.56	0.95	6	3.10	0.31
2	3.47	0.95	9.5	3.00	0.00
11	2.36	1.37	9.5	3.00	0.00
12	2.31	1.22	9.5	3.00	0.00
9	2.92	1.06	9.5	3.00	0.00
6	3.14	1.13	4	3.17	0.57

COMPARISON OF GRADUATES WORKING AS AN ELECTRONICS TECHNICIAN AND EMPLOYERS RESPONSE

Table 47

AC-DC Machinery

Analyze the operation of DC generators.

Study and use the conventions for generators and motors.

Test the performance of different types of DC motors.

Analyze the operation of AC generators.

Set up and verify the load characteristics of a polyphase motor.

Verify the losses and efficiency of a motor by different methods.

Record the advantages and disadvantages of several types of single phase motors.

Set up and verify the operating characteristics of different types of synchros.

Verify the polarity and load performance of a transformer.

Verify the transformer losses and equivalent circuit.

Calculate transformer efficiency and voltage regulation.

Test the performance of different three phase connections.

Calculate the mechanical characteristics of a servo system.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
5	3.14	1.26	1.5	3.00	0.00
1	3.36	0.70	1.5	3.00	0.00
8	3.08	1.23	11.5	2.00	0.00
9	3.07	1.14	11.5	2.00	0.00
11.5	2.89	1.15	4	2.90	0.30
10	3.06	1.15	11.5	2.00	0.00
6.5	3.11	1.17	7.5	2.89	3.33
6.5	3.11	1.20	11.5	2.00	0.00
2.5	3.22	0.94	4	2.90	0.30
2.5	3.22	1.05	7.5	2.89	0.31
4	3.17	1.09	7.5	2.89	0.31
11.5	2.89	1.10	4	2.90	0.30
7.5	2.78	1.13	7.5	2.89	0.31

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 48

Electronics Projects

Connect, evaluate and troubleshoot linear integrated circuits.

Identify integrated-circuit logic and memories.

Connect, evaluate and troubleshoot digital integrated circuit sub-systems.

Design, construct and troubleshoot electronic projects.

Use the guidelines of technical report writing to write project reports.

Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.

Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).

Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.

Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, phototransistors, photothyristors, and opto-isolators.

Connect and test A/D and D/A converters.

Connect and test the phase lock loop circuits.

Connect and analyze active filters and phase-shifters.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	3.34	1.13	3	3.50	0.95
1	3.36	1.31	2	3.54	0.87
4.5	3.19	1.39	1	3.64	0.98
3	3.28	1.25	8.5	3.00	0.42
7	3.00	1.35	12	2.50	0.64
4.5	3.19	1.26	6	3.33	0.64
6	3.03	1.40	4.5	3.36	1.03
11	2.53	1.25	8.5	3.00	0.87
9.5	2.64	1.15	4.5	3.36	0.60
9.5	2.64	1.39	8.5	3.00	0.40
12	2.28	1.14	8.5	3.00	0.40
8	2.81	1.08	11	2.91	0.28

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 49

Industrial Electronics

	Graduates Preparation at School			Employers Preparation at School		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Construct solid state controls.	11	2.89	1.15	8.5	3.00	0.33
Calculate and test phase shift control circuits.	6.5	3.03	1.14	12	2.78	0.42
Set up and test a SCR with AC bias control.	3	3.17	1.16	8.5	3.00	0.33
Set up and test the response of photoelectric devices.	9.5	2.92	1.14	6	3.10	0.30
Set up and test the photoelectric control of a SCR.	9.5	2.92	1.23	3	3.30	1.41
Test different types of relay circuits.	4	3.11	1.17	1	3.50	0.76
Test different types of timing circuits.	2	3.22	0.94	2	3.33	0.86
Set and test delay relay circuit.	8	3.00	1.24	4	3.27	0.60
Use the UJT as a triggering device.	1	3.42	1.11	8.5	3.00	0.00
Graph curve of variable reluctance phase shift circuit.	12	2.67	1.29	11	2.89	0.33
Set up and test different motor control circuits.	5	3.08	1.21	5	3.20	0.74
Set up and test different servo systems.	6.5	3.03	1.16	8.5	3.00	0.77

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND EMPLOYERS RESPONSE

Table 50

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

Graduates Preparation at School			Employers Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	3.17	1.40	8	3.33	1.11
1	3.53	1.28	4.5	3.42	0.95
3	3.14	1.24	2	3.46	1.15
9	2.67	1.37	4.5	3.42	0.95
13	2.36	1.26	13	3.08	1.08
4	3.11	0.84	11	3.25	0.83
5	3.06	1.47	3	3.45	1.08
8	2.75	1.50	6	3.40	1.01
12	2.42	1.38	9.5	3.27	1.05
10.5	2.61	1.42	12	3.18	0.93
14	2.17	1.23	14	3.00	0.73
6	3.03	1.25	1	3.50	1.04
10.5	2.61	1.21	7	3.36	0.79
7	2.78	1.20	9.5	3.27	0.96

Chapter VII

Comparison of Graduates Working as Electronic Technicians and Graduates Working in a Related Field Response

In an effort to determine the degree of agreement between Electronic Technology graduates working in the field and those working in a related field, a comparison of responses was made. It was assumed that the two groups would have a difference of opinion, particularly Importance on Job.

Tables 51-60 compare competency by rank, mean and standard deviation for Importance on Job, tables 61-70 for Preparation at School and tables 71-80 for Adequacy of Instructional Equipment.

Summary of Comparisons of Importance on Job

Of the 120 competencies, the graduates working in the field had a higher mean on 72 of them, the graduates working in a related field had a higher mean on 45 of them and the two groups had the same mean on three of the competencies.

Following is a list of the 12 competencies with the highest difference of mean, who had the highest mean, table where found and the competency. Since Importance on Job was rated from 1 (no knowledge necessary) to 5 (knowledge essential), a difference in mean of 0.65 or greater may be considered important.

<u>Difference in Mean</u>	<u>Higher Mean</u>	<u>Table</u>	<u>Competency</u>
1.11	Related*	53	Use drafting equipment and procedures to represent electronic data.
1.00	Field**	60	Connect, test and troubleshoot logic circuits.
0.87	Field	60	Use test equipment to troubleshoot the malfunctions of electronic equipment.
0.85	Field	52	Assemble, interconnect and test cables and connectors.
0.84	Field	60	Use test equipment to troubleshoot the malfunctions of electronic equipment.
0.81	Related	53	Prepare block diagram for electronic and computer systems.
0.79	Related	58	Use the guidelines of technical report writing to write project reports.
0.78	Field	60	Connect, test and troubleshoot computer control circuits.
0.69	Field	58	Connect, evaluate and troubleshoot linear integrated circuits.
0.67	Related	55	Calculate and measure the input impedance and output impedance of a given transistor amplifier.
0.66	Field	51	Describe the principles of the primary cells and secondary cells.
0.65	Field	58	Connect, evaluate and troubleshoot digital integrated circuit sub-systems.

*Graduates working in a related field.

**Graduates working in the field as an Electronics Technician.

Summary of Comparisons of Preparation at School

Of the 120 competencies, the graduates working in the field had a higher mean on 25 of them, the graduates working in a related field had a higher mean on 94 of them and the two groups had the same mean on one of the competencies.

Following is a list of the 12 competencies with the highest difference of mean, who had the highest mean, table where found and the competency. Since Preparation at School was rated from 1 (unprepared) to 5 (excellent preparation), a difference in mean of .70 may be considered important.

<u>Difference in Mean</u>	<u>Higher Mean</u>	<u>Table</u>	<u>Competency</u>
1.79	Related*	61	Describe the properties of permanent magnetism and electromagnetism.
1.03	Related	61	Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.
0.99	Related	61	Design different meters using a DC meter movement.
0.96	Related	61	Identify the effects of capacitance and inductance in DC.
0.94	Related	62	Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.
0.81	Related	62	Assemble, interconnect and test cables and connectors.
0.79	Related	68	Use the guidelines of technical report writing to write project reports.
0.76	Related	61	Verify series and parallel circuit operation using Kirchoff's Law.
0.76	Related	62	Solder and desolder printed circuit boards, interconnection wires.
0.76	Related	66	Find the harmonic present in a mixer.
0.72	Related	64	Calculate the effect of capacitance in an AC circuit.
0.72	Related	68	Connect and test A/D and D/A converters.

*Graduate working in a related field.

Summary of Comparisons of Adequacy of Instructional Equipment

Of the 120 competencies, the graduates working in the field had a higher mean on 35 of them, the graduates working in a related field had a higher mean on 83 of them and the two groups had the same mean on two of the competencies.

On the following page is a list of the 12 competencies with the highest difference of mean, who has the highest mean, table where found and the competency. Since Adequacy of Instructional Equipment was rated from 1 (poor) to 3 (excellent), a difference in mean of 0.30 or greater may be considered important.

<u>Difference in Mean</u>	<u>Higher Mean</u>	<u>Table</u>	<u>Competency</u>
0.51	Related*	71	Design different meters using a DC meter movement.
0.51	Related	78	Use the guidelines of technical report writing to write project reports.
0.49	Related	76	Find the harmonics present in a mixer.
0.47	Field**	78	Connect, evaluate and troubleshoot digital integrated circuit sub-systems.
0.40	Related	71	Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.
0.40	Related	72	Assemble, interconnect and test cables and connectors.
0.40	Field	79	Set up and test a SCR with AC bias control.
0.37	Related	73	Use drafting equipment and procedures to represent electronics data.
0.35	Related	76	Construct, analyze and troubleshoot operational amplifier circuits.
0.35	Related	76	Calculate and test the effects of modulation.
0.35	Related	74	Solve problems involving three phase systems.
0.32	Field	79	Calculate and test phase shift control circuits.

*Graduates working in a related field.

**Graduates working in the field as an Electronics Technician.

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 51

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenins theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

In-Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.47	0.80	1	3.92	1.22
2	4.06	0.91	2	3.71	1.03
3	3.56	1.04	3	3.57	1.19
8	2.42	1.01	8	2.50	1.30
10	2.22	1.17	10	2.07	1.48
14	1.47	1.01	12.5	1.78	1.13
5	2.72	1.02	4	3.00	1.25
4	2.97	1.30	6	2.85	1.41
7	2.44	0.64	12.5	1.78	1.01
9	2.33	1.39	5	2.86	1.30
13	1.72	1.09	11	2.00	1.06
6	2.61	1.30	7	2.73	1.06
12	1.97	1.16	14	1.71	0.80
11	2.11	1.35	9	2.43	1.23

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 52

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

In Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	4.08	1.06	2	3.79	1.20
1	4.17	0.79	1	3.93	1.48
7	2.81	1.60	7	2.64	1.48
10	2.11	1.31	8.5	2.50	1.50
5	3.89	1.13	3	3.64	1.53
11	2.06	1.25	11	2.14	1.13
3.5	3.92	1.26	4	3.43	1.23
8	2.72	1.41	8.5	2.50	0.98
9	2.53	1.36	10	2.43	1.18
6	3.36	1.29	5.5	3.07	1.16
3.5	3.92	1.12	5.5	3.07	1.16

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 53

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military and engineering standards in electronics work.

1	4.58	0.76	1	4.43	0.90
3	2.75	1.44	3	3.21	1.82
6	1.80	1.05	6	2.43	1.50
4	2.39	1.44	4	3.20	1.53
5	2.11	1.35	2	3.22	0.87
2	2.86	1.41	5	3.07	1.58

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 54

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

In Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.50	0.86	1	4.00	1.00
2	3.86	1.03	2	3.57	0.65
5	3.03	1.24	3	3.00	1.25
3	3.14	1.25	4	3.14	1.46
6	2.89	1.58	5	2.86	1.46
4	3.08	1.36	6	2.71	1.38
11	2.42	1.30	8	2.21	0.67
8	2.56	1.32	10	2.00	1.00
12	2.30	1.20	10	2.00	1.00
10	2.50	1.25	10	2.00	1.00
7	2.81	1.37	7	2.43	1.17
9	2.53	1.40	12	1.93	1.38

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 55

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

In-Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.31	1.43	1.5	3.14	1.25
4	2.89	1.49	3.5	3.00	1.19
5	2.86	1.20	6	2.71	1.48
2.5	3.17	1.44	3.5	3.00	1.19
2.5	3.17	1.42	5	2.93	1.48
8	2.06	1.15	8.5	2.50	1.54
11	1.83	0.68	8.5	2.50	1.45
6	2.42	1.46	10	2.36	1.33
14	1.69	1.05	13	2.07	1.10
11	1.83	1.06	12	2.14	1.30
13	1.78	0.94	1.5	3.14	0.53
9	1.92	1.16	14	1.93	1.16
11	1.83	1.01	11	2.21	1.26
7	2.11	1.31	7	2.57	1.50

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 56

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

In Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
8	1.92	1.64	6.5	2.07	1.28
6	2.33	1.37	6.5	2.07	1.28
9	1.89	1.33	10.5	1.64	0.89
7	1.94	1.17	12	1.43	0.81
4	2.55	1.38	4	2.28	1.22
2	2.81	1.39	2	2.43	1.17
3	2.69	1.54	3	2.36	1.38
5	2.47	1.34	5	2.14	1.24
11	1.75	1.09	8	1.93	1.22
12	1.47	0.68	10.5	1.64	0.89
10	1.81	1.05	9	1.71	0.70
1	3.22	1.37	1	2.67	1.29

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 57

AC-DC Machinery

Analyze the operation of DC generators.

Study and use the conventions for generators and motors.

Test the performance of different types of DC motors.

Analyze the operation of AC generators.

Set up and verify the load characteristics of a polyphase motor.

Verify the losses and efficiency of a motor by different methods.

Record the advantages and disadvantages of several types of single phase motors.

Set up and verify the operating characteristics of different types of synchros.

Verify the polarity and load performance of a transformer.

Verify the transformer losses and equivalent circuit.

Calculate transformer efficiency and voltage regulation.

Test the performance of different three phase connections.

Calculate the mechanical characteristics of a servo system.

In Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
6	2.17	1.44	8	2.00	0.92
2	2.42	1.40	4	2.21	1.01
5	2.28	1.32	1.5	2.50	1.23
8.5	2.00	1.26	5	2.14	1.05
11	1.83	1.25	13	1.71	0.96
12.5	1.75	1.16	9.5	1.93	1.10
12.5	1.75	1.04	6	2.07	1.16
8.5	2.00	1.31	9.5	1.93	0.88
1	2.50	1.16	1.5	2.50	1.11
4	2.31	1.43	7	2.04	0.81
3	2.39	1.32	3	2.29	1.22
7	2.11	1.35	12	1.79	0.94
10	1.92	1.30	11	1.36	0.82

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 58

Electronics Projects

	In Field Importance on Job			Related Field Importance on Job		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Connect, evaluate and troubleshoot linear integrated circuits.	3	3.69	1.35	6.5	3.00	1.46
Identify integrated-circuit logic and memories.	2	3.81	1.41	3	3.36	1.28
Connect, evaluate and troubleshoot digital integrated circuit sub-systems.	4	3.64	1.61	6.5	3.00	1.60
Design, construct and troubleshoot electronic projects.	6	3.25	1.58	10	2.64	1.48
Use the guidelines of technical report writing to write project reports.	11.5	2.42	1.16	4	3.21	1.30
Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.	5	3.36	1.41	2	3.43	1.34
Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).	1	4.06	1.15	1	3.57	1.32
Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.	9	2.92	1.40	8.5	2.86	1.06
Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.	7	3.19	1.49	8.5	2.86	1.51
Connect and test A/D and D/A converters.	8	3.00	1.41	5	3.07	1.53
Connect and test the phase lock loop circuits.	11.5	2.42	1.44	12	2.43	1.34
Connect and analyze active filters and phase-shifters.	10	2.47	1.40	11	2.50	1.34

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 59

Industrial Electronics

Construct solid state controls.

Calculate and test phase shift control circuits.

Set up and test a SCR with AC bias control.

Set up and test the response of photoelectric devices.

Set up and test the photoelectric control of a SCR.

Test different types of relay circuits.

Test different types of timing circuits.

Set and test delay relay circuit.

Use the UJT as a triggering device.

Graph curve of variable reluctance phase shift circuit.

Set up and test different motor control circuits.

Set up and test different servo systems.

In Field Importance on Job			Related Field Importance on Job		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
6	2.50	1.36	5	2.50	1.54
8	2.31	1.39	11	1.93	1.10
7	2.39	1.46	6	2.36	1.10
4	2.56	1.34	4	2.64	1.38
10	2.28	1.23	7.5	2.29	1.28
1	3.19	1.35	1	3.14	0.70
2	3.11	1.41	2	3.07	1.58
3	2.94	1.49	3	2.93	1.43
9	2.30	1.49	9.5	2.21	1.26
12	1.47	0.72	12	1.64	0.88
5	2.53	1.44	7.5	2.29	0.88
11	2.22	1.33	9.5	2.21	1.26

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 60
Micro Computer

	In Field Importance on Job			Related Field Importance on Job		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Identify the functions and applications of a digital computer.	5	3.58	1.64	3	3.57	1.21
Apply the principles of Boolean Algebra to the digital circuit.	11	2.97	1.60	10.5	3.14	1.64
Connect, test and troubleshoot logic circuits.	3	4.14	1.29	10.5	3.14	1.51
Connect, test and troubleshoot computer control circuits.	4	3.78	1.58	12.5	3.00	1.55
Connect, test and troubleshoot computer memory circuits.	6.5	3.42	1.69	14	2.93	1.66
Develop, load and run programs on a minicomputer or a microcomputer.	9	3.11	1.76	7	3.31	1.64
Identify digital codes and mnemonic codes.	6.5	3.42	1.74	8	3.21	1.64
Describe the architecture of microprocessor and micro-computer.	10	3.06	1.73	12.5	3.00	1.64
Interface microprocessor with I/O.	8	3.19	1.63	6	3.36	1.73
Write, debug and run micro-computer programs.	12	2.94	1.68	2	3.43	1.58
Use control bus for external controllers.	13	2.92	1.65	9	3.20	1.69
Use standard test equipment and procedure to check performance of electronics system.	2	4.19	1.39	1	3.79	0.92
Use test equipment to calibrate electronic equipment.	14	2.56	1.48	5	3.40	1.54
Use test equipment to troubleshoot the malfunctions of electronic equipment.	1	4.47	1.06	2	3.60	1.36

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 61

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenins theorem, Norton's theorem, Delta-ye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2.5	4.11	0.88	5.5	4.36	0.59
2.5	4.11	0.91	4	4.50	0.59
1	4.33	0.83	1	4.86	0.26
4	4.00	0.85	2	4.76	0.46
6	3.75	0.95	5.5	4.36	0.80
10	3.08	1.21	9.5	4.07	0.80
8	3.61	0.86	3	4.57	0.53
5	3.94	0.91	8	4.21	1.25
13	2.75	1.04	13	3.36	1.01
14	2.28	0.95	9.5	4.07	0.70
11	3.00	0.91	12	3.71	0.88
7	3.72	0.95	7	4.29	0.70
9	3.50	1.04	10.5	4.00	1.06
12	2.97	1.01	10.5	4.00	0.92

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 62

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.53	1.25	1	4.07	1.07
3	2.83	1.60	2	3.77	1.12
4	2.80	1.20	8	3.23	1.30
5	2.69	1.31	9	3.21	1.51
2	2.86	1.10	3.5	3.43	1.33
11	2.39	1.21	11	2.79	1.19
7	2.67	0.94	3.5	3.43	1.03
7	2.67	1.17	6.5	3.29	1.22
10	2.47	1.14	10	3.07	1.16
7	2.67	1.10	6.5	3.29	1.03
9	2.61	1.00	5	3.42	1.17

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 63

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

1	3.97	0.95	1	4.33	0.60
2	3.53	1.09	2	3.71	0.70
4.5	2.89	1.20	6	3.14	1.00
3	2.94	1.24	3	3.57	0.82
4.5	2.89	1.08	4	3.43	0.97
6	2.67	1.15	5	3.21	0.84

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 64

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	3.92	1.14	2	4.29	0.88
2	3.89	0.97	3.5	4.21	0.67
9.5	3.64	0.97	1	4.36	0.70
11	3.61	1.04	3.5	4.21	0.67
5.5	3.69	0.91	5	4.20	0.77
9.5	3.64	0.97	6	4.07	0.80
3.5	3.75	0.98	7	3.86	0.92
3.5	3.75	0.80	8.5	3.71	1.16
7.5	3.67	0.94	8.5	3.71	0.96
7.5	3.67	0.94	11.5	3.64	1.10
5.5	3.69	1.08	11.5	3.64	0.96
12	3.47	0.86	10	3.70	0.88

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	4.03	0.89	1.5	4.07	1.22
11	3.42	1.21	9.5	3.64	0.96
3	3.72	0.98	5	3.86	0.75
9.5	3.58	1.14	6.5	3.79	0.77
9.5	3.58	1.19	3.5	4.00	0.84
5.5	3.67	0.97	6.5	3.79	0.92
4	3.69	0.97	3.5	4.00	0.92
2	3.75	1.06	1.5	4.07	0.96
14	3.00	1.22	8	3.71	1.10
5.5	3.67	1.05	9.5	3.64	0.96
12	3.33	1.15	12.5	3.43	1.03
7	3.64	0.85	12.5	3.43	1.48
8	3.61	1.01	11	3.50	0.90
13	3.5	1.23	14	3.21	1.01

Table 65

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Evaluate device parameters of diodes and transistors.

Construct, analyze and troubleshoot small-signal transistor amplifier.

Construct, analyze and troubleshoot power transistor amplifier.

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Calculate and measure the input impedance and output impedance of a given transistor amplifier.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Model a transistor circuit for AC or DC in order to obtain the transfer function.

Apply the load line technique and the operating point to classify the amplifier operation.

Construct and analyze the varied interstage couplings to insure the maximum power transfer.

Calculate the cascaded amplifier gain.

Measure and calculate the frequency band-width of a transistor amplifier.

Measure the temperature effect on transistor amplifiers operation.

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 66

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
4.5	3.17	0.55	2.5	3.64	1.04
8	3.03	0.98	6.5	3.50	1.05
10	2.39	1.14	11	2.93	1.53
3	3.28	1.06	9.5	3.07	1.33
7	3.08	1.01	6.5	3.50	1.11
4.5	3.17	1.04	2.5	3.64	1.04
1	3.56	0.95	2.5	3.64	0.88
2	3.47	0.95	2.5	3.64	0.80
11	2.36	1.37	12	2.64	1.22
12	2.31	1.22	9.5	3.07	1.22
9	2.92	1.06	8	3.43	1.11
6	3.14	1.13	5	3.57	0.82

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 67

AC-DC Machinery

	In Field Preparation at School			Related Field Preparation at School		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
Analyze the operation of DC generators.	5	3.14	1.26	2.5	3.57	1.05
Study and use the conventions for generators and motors.	1	3.36	0.70	2.5	3.57	0.98
Test the performance of different types of DC motors.	8	3.08	1.23	8	3.21	1.08
Analyze the operation of AC generators.	9	3.07	1.14	6.5	3.29	1.10
Set up and verify the load characteristics of a polyphase motor.	11.5	2.89	1.15	12.5	2.79	1.08
Verify the losses and efficiency of a motor by different methods.	10	3.06	1.15	10	3.07	1.22
Record the advantages and disadvantages of several types of single phase motors.	6.5	3.11	1.17	6.5	3.29	1.03
Set up and verify the operating characteristics of different types of synchros.	6.5	3.11	1.20	9	3.14	1.13
Verify the polarity and load performance of a transformer.	2.5	3.22	0.94	1	3.64	0.72
Verify the transformer losses and equivalent circuit.	2.5	3.22	1.05	5	3.36	0.96
Calculate transformer efficiency and voltage regulation.	4	3.17	1.09	4	3.50	0.98
Test the performance of different three phase connections.	11.5	2.89	1.10	11	2.93	1.10
Calculate the mechanical characteristics of a servo system.	13	2.78	1.13	12.5	2.79	1.14

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 68

Electronics Projects

Connect, evaluate and troubleshoot linear integrated circuits.

Identify integrated-circuit logic and memories.

Connect, evaluate and troubleshoot digital integrated circuit sub-systems.

Design, construct and troubleshoot electronic projects.

Use the guidelines of technical report writing to write project reports.

Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.

Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).

Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.

Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.

Connect and test A/D and D/A converters.

Connect and test the phase lock loop circuits.

Connect and analyze active filters and phase-shifters.

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	3.34	1.13	7	3.29	1.33
1	3.36	1.31	5.5	3.36	1.16
4.5	3.19	1.39	8	3.14	1.41
3	3.28	1.25	3	3.57	0.94
7	3.00	1.35	1	3.79	0.92
4.5	3.19	1.26	3	3.57	0.98
6	3.03	1.40	3	3.57	1.18
11	2.53	1.25	10	2.93	1.16
9.5	2.64	1.15	11	2.86	1.19
9.5	2.64	1.39	5.5	3.36	1.16
12	2.28	1.14	12	2.71	0.88
8	2.81	1.08	9	3.07	0.59

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

	In Field Preparation at School			Related Field Preparation at School		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
<u>Table 69</u> <u>Industrial Electronics</u>						
Construct solid state controls.	11	2.89	1.15	9	2.86	1.30
Calculate and test phase shift control circuits.	6.5	3.03	1.14	7	2.93	1.16
Set up and test a SCR with AC bias control.	3	3.17	1.16	5	3.07	1.16
Set up and test the response of photoelectric devices.	9.5	2.92	1.14	7	2.93	1.10
Set up and test the photoelectric control of a SCR.	9.5	2.92	1.23	7	2.93	1.10
Test different types of relay circuits.	4	3.11	1.17	3	3.36	0.80
Test different types of timing circuits.	2	3.22	0.94	2	3.43	0.73
Set and test delay relay circuit.	8	3.00	1.24	4	3.29	0.80
Use the UJT as a triggering device.	1	3.42	1.11	1	3.46	0.80
Graph curve of variable reluctance phase shift circuit.	12	2.67	1.29	11	2.85	1.24
Set up and test different motor control circuits.	5	3.08	1.21	11	2.85	0.96
Set up and test different servo systems.	6.5	3.03	1.16	11	2.85	1.10

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 70

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

In Field Preparation at School			Related Field Preparation at School		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
2	3.17	1.40	6.5	2.86	1.13
1	3.53	1.28	1	3.21	1.30
3	3.14	1.24	5	2.93	0.96
9	2.67	1.37	8	2.64	1.10
13	2.36	1.26	10.5	2.50	1.18
4	3.11	0.84	6.5	2.86	1.05
5	3.06	1.47	9	2.57	1.11
8	2.75	1.50	10.5	2.50	1.23
12	2.42	1.38	12.5	2.36	1.17
10.5	2.61	1.42	12.5	2.36	1.16
14	2.17	1.23	14	2.33	1.19
6	3.03	1.25	3	3.13	0.89
10.5	2.61	1.21	4	3.00	0.96
7	2.78	1.20	2	3.20	0.65

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 71

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenin's theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

In Field Adequacy of Instructional Equipment			Related Field Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1.5	2.53	0.50	4.5	2.50	0.50
3	2.50	0.72	7.5	2.43	0.50
4	2.47	0.66	1.5	2.57	0.50
6	2.39	0.50	1.5	2.57	0.50
1.5	2.53	0.64	6	2.49	0.50
10.5	2.00	0.74	3	2.51	0.50
8	2.28	0.52	9	2.36	0.61
5	2.44	0.55	7.5	2.43	0.50
13	1.86	0.57	13	2.00	0.65
10.5	2.00	0.62	12.5	2.07	0.59
12	1.94	0.52	12.5	2.07	0.59
7	2.31	0.47	4.5	2.50	0.50
9	2.14	0.63	10.5	2.21	0.67
14	1.81	0.62	10.5	2.21	0.67

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 72

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect and test cables and connectors.

In Field			Related Field		
Adequacy of Instructional Equipment			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
1	2.19	0.67	1	2.31	0.72
2	1.89	0.74	2	2.15	0.77
7	1.78	0.62	9.5	1.85	0.77
4.5	1.83	0.68	7.5	1.86	0.74
3	1.86	0.62	4.5	2.00	0.75
9.5	1.67	0.66	9.5	1.85	0.74
6	1.81	0.62	4.5	2.00	0.75
4.5	1.83	0.60	6	1.93	0.95
11	1.61	0.60	7.5	1.86	0.74
8	1.72	0.64	11	1.79	0.67
9.5	1.67	0.57	3	2.07	0.70

Table 73

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military military and engineering standards in electronics work.

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 74

	In Field			Related Field		
	Adequacy of Instructional Equipment			Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
<u>Principles of Alternating Current</u>						
Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.	1	2.50	0.68	1.5	2.64	0.47
Define the characteristics of AC currents and voltages.	2	2.44	0.50	1.5	2.64	0.47
Calculate the effect of capacitance in an AC circuit.	3	2.42	0.55	5.0	2.50	0.50
Verify the effect of capacitance in an AC circuit.	7.5	2.31	0.57	5.0	2.50	0.50
Calculate the effect of inductance in an AC circuit.	5.5	2.33	0.52	5.0	2.50	0.50
Verify the effect of inductance in an AC circuit.	7.5	2.31	0.52	5.0	2.50	0.50
Calculate the impedance, phase angle, power and voltage in series circuits.	4	2.36	0.57	5.0	2.50	0.50
Measure the impedance, phase angle, power and voltage in series circuits.	10	2.25	0.60	10.5	2.29	0.80
Calculate the impedance, phase angle, power and current in parallel circuits.	9	2.28	0.60	8.5	2.43	1.04
Measure the impedance, phase angle, power and current in parallel circuits.	11	2.22	0.63	10.5	2.29	0.70
Solve problems involving AC networks.	5.5	2.33	0.57	12	2.21	0.67
Solve problems involving three phase systems.	12	2.08	0.64	8.5	2.43	1.04

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 75

	In Field Adequacy of Instructional Equipment			Related Field Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
<u>Principles of Electronics</u>						
Identify the characteristics of semiconductors and properties of PN junctions.	1	2.47	0.55	3	2.50	0.50
Breadboard, operate and troubleshoot the diode rectifier, diode filter and diode clamper.	11.5	2.25	0.68	10.5	2.36	0.47
Evaluate device parameters of diodes and transistors.	7.5	2.33	0.57	6.0	2.43	0.49
Construct, analyze and troubleshoot small-signal transistor amplifier.	7.5	2.33	0.57	6.0	2.43	0.49
Construct, analyze and troubleshoot power transistor amplifier.	2	2.44	0.55	6.0	2.43	0.62
Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.	4.5	2.36	0.47	10.5	2.36	0.59
Calculate and measure the input impedance and output impedance of a given transistor amplifier.	7.5	2.33	0.70	2	2.51	0.50
Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.	3	2.42	0.60	4	2.49	0.62
Model a transistor circuit for AC or DC in order to obtain the transfer function.	13	2.14	0.66	8.5	2.37	0.70
Apply the load line technique and the operating point to classify the amplifier operation.	4.5	2.36	0.57	1	2.52	0.62
Construct and analyze the varied interstage couplings to insure the maximum power transfer.	11.5	2.25	0.60	12.5	2.35	0.70
Calculate the cascaded amplifier gain.	7.5	2.33	0.57	8.5	2.37	0.70
Measure and calculate the frequency band-width of a transistor amplifier.	10	2.31	0.52	12.5	2.35	0.47
Measure the temperature effect on transistor amplifiers operation.	14	2.11	0.66	14	2.29	0.70

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 76

Electronic Circuits

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

In Field Adequacy of Instructional Equipment			Related Field Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
4.0	2.17	0.55	2	2.43	0.72
4.0	2.17	0.60	6	2.36	0.71
9.5	1.94	0.62	10	2.14	0.83
8	2.06	0.66	6	2.36	0.60
6	2.11	0.52	6	2.36	0.60
7	2.08	0.55	2	2.43	0.62
1	2.28	0.79	2	2.43	0.50
2	2.25	0.49	4	2.37	0.47
11	1.64	0.74	12	1.71	0.80
12	1.58	0.68	11	2.07	0.70
9.5	1.94	0.57	8	2.29	0.59
4.0	2.17	0.55	9	2.21	0.56

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 77

	In Field Adequacy of Instructional Equipment			Related Field Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
<u>AC-DC Machinery</u>						
Analyze the operation of DC generators.	2	2.14	0.66	1.5	2.21	0.77
Study and use the conventions for generators and motors.	2	2.14	0.66	5.5	2.07	0.70
Test the performance of different types of DC motors.	9	2.06	0.74	5.5	2.07	0.70
Analyze the operation of AC generators.	9	2.06	0.70	5.5	2.07	0.70
Set up and verify the load characteristics of a polyphase motor.	12	2.00	0.70	13	1.86	0.63
Verify the losses and efficiency of a motor by different methods.	6	2.03	0.72	9.5	2.00	0.75
Record the advantages and disadvantages of several types of single phase motors.	6	2.08	0.68	12	1.93	0.70
Set up and verify the operating characteristics of different types of synchros.	9	2.06	0.62	9.5	2.00	0.65
Verify the polarity and load performance of a transformer.	6	2.08	0.64	3	2.14	0.63
Verify the transformer losses and equivalent circuit.	4	2.11	0.88	5.5	2.07	0.59
Calculate transformer efficiency and voltage regulation.	2	2.14	0.63	1.5	2.21	0.67
Test the performance of different three phase connections.	11	2.03	0.72	9.5	2.00	0.65
Calculate the mechanical characteristics of a servo system.	13	1.89	0.74	9.5	2.00	0.75

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 78

	In Field Adequacy of Instructional Equipment			Related Field Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
<u>Electronics Projects</u>						
Connect, evaluate and troubleshoot linear integrated circuits.	4	2.11	0.70	7	2.00	0.84
Identify integrated-circuit logic and memories.	2	2.14	0.64	4	2.07	0.80
Connect, evaluate and troubleshoot digital integrated circuit sub-systems.	6	1.97	0.79	12	1.50	1.80
Design, construct and troubleshoot electronic projects.	2	2.14	0.70	2	2.28	0.70
Use the guidelines of technical report writing to write project reports.	7	1.92	0.72	1	2.43	0.62
Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.	2	2.14	0.74	7	2.00	0.75
Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).	5	2.00	0.84	7	2.00	0.75
Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.	11	1.72	0.79	9.5	1.86	0.83
Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, phototransistors, photothyristors, and opto-isolators.	10	1.81	0.69	11	1.78	0.67
Connect and test A/D and D/A converters.	9	1.85	0.73	4	2.07	0.70
Connect and test the phase lock loop circuits.	12	1.67	0.66	9.5	1.86	0.63
Connect and analyze active filters and phase-shifters.	8	1.89	0.56	4	2.07	0.46

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 79

	In Field			Related Field		
	Adequacy of Instructional Equipment			Adequacy of Instructional Equipment		
	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
<u>Industrial Electronics</u>						
Construct solid state controls.	7	2.00	0.70	11.5	1.71	0.70
Calculate and test phase shift control circuits.	3	2.11	0.57	7.5	1.79	0.67
Set up and test a SCR with AC bias control.	3	2.11	0.57	11.5	1.71	0.70
Set up and test the response of photoelectric devices.	11	1.94	0.70	7.5	1.79	0.86
Set up and test the photoelectric control of a SCR.	7	2.00	0.66	5	1.92	0.73
Test different types of relay circuits.	9.5	1.97	0.64	3.5	2.00	0.67
Test different types of timing circuits.	3	2.11	0.62	1.5	2.08	0.62
Set and test delay relay circuit.	5	2.06	0.66	1.5	2.08	0.62
Use the UJT as a triggering device.	1	2.17	0.64	3.5	2.00	0.55
Graph curve of variable reluctance phase shift circuit.	12	1.89	0.70	6	1.85	1.10
Set up and test different motor control circuits.	9.5	1.97	0.72	9.5	1.77	0.69
Set up and test different servo systems.	7	2.00	0.47	9.5	1.77	0.69

COMPARISON OF GRADUATES WORKING AS AN ELECTRONIC TECHNICIAN AND GRADUATES WORKING IN A RELATED FIELD

Table 80

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

In Field			Related Field		
Adequacy of Instructional Equipment			Adequacy of Instructional Equipment		
Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation
3	2.11	0.81	7	2.00	0.65
1	2.19	0.74	3	2.14	0.63
4.5	2.08	0.68	2	2.21	0.77
10	1.81	0.78	9	1.93	0.70
12	1.69	0.74	9	1.93	0.70
8	1.83	0.83	5	2.07	0.59
6	1.97	0.76	9	1.93	0.70
10	1.81	0.78	12	1.79	0.77
13	1.58	0.72	13.5	1.71	0.70
10	1.81	0.81	13.5	1.71	0.70
14	1.53	0.68	11	1.80	0.74
2	2.17	0.83	5	2.07	0.68
7	1.89	0.66	5	2.07	0.68
4.5	2.08	0.68	1	2.27	0.57

Chapter VIII

Electronic Technicians Interview Results

The interviewing was initiated by selecting names at random from the graduate list as each list was received from each school. Graduates were contacted by phone, setting up an appointment. Enough time was allowed for the interviewee to receive the instrument and to fill it out before the interview took place.

In many cases, phone contact was unsuccessful. Thus to get more interviews, some graduates who had returned the mail instrument were called and interviewed.

The interviewer asked five questions:

1. Do you feel there are any skills you should have been taught in your program that you weren't taught? This could be competencies on the survey but not taught at all schools or some competency not on the survey. See Table 81 for results.
2. Were there any skills you learned that weren't on the list that are important to your job? This could be a competency taught at some schools but not at Gateway. See Table 82 for results.
3. The questions were a) Did you check any primary area with (1) No Knowledge Necessary? b) Should that area still be required? This was an effort to find out if a competency not used is still important and should be retained. See Table 83 for results.
4. What program modification can you think of that would improve the program? This question gave the interviewee a chance to offer suggestions for improvement. See Table 84 for results.
5. General Comments - This gave the interviewee a chance to suggest things outside the program courses for improvement. See Table 85 for results.

Summary of Interview Questions

Table 81 results -- All positive responses are recorded on Table 81. The major areas the graduates felt they weren't given enough training in were micro processors, computer language and troubleshooting skills. What this highlights is that the electronic technology graduate has a need for some of the basic computer skills. Troubleshooting is another high response item. This is partially due to limited amount of equipment and time. The rest of the responses were diversified, showing no general area of weakness in the electronic technology programs throughout the state.

Table 82 results -- The majority of the graduates responded negatively to this question. The few who did respond, there doesn't seem to be any area that stands out. This verifies that the broad competencies on the survey instruments cover the broad competencies taught in the electronic technology programs throughout the state.

Table 83 results -- As expected, most graduates felt there were areas taught in the electronic technology program that weren't necessary in their present job. These graduates did have the foresight to see the need for these skills by overwhelmingly responding that they need to be retained in the program. A graduate in electronic technology can branch off in many different ways. This is the reason for a broad course of study in electronics.

Table 84 results -- Only modifications with more than one response are recorded in Table 84. One can see the major modifications suggested in Table 84 follow the major areas not taught in the graduate's program from Table 81. This shows the need for more computer courses in the electronic technology program plus the need for additional troubleshooting on actual equipment. The troubleshooting can go hand-in-hand with more lab time and greater emphasis on planning labs. The rest of the comments seemed to be geared towards the graduates type of employment.

Table 85 results -- There were mixed feelings about general education courses. Many graduates did not see the need for economics or social science skills while several students felt communication skills and physical science skills should be expanded. Overall, the general feeling of most of the graduates was if they couldn't see a direct need for a particular skill, they felt the time could be better utilized in their major area.

Question #1 -- Do you feel there are any skills you should have been taught in your program that you weren't taught?

Table 81

<u>Skill</u>	<u>Number of Responses</u>
1. Micro Processors skills	15
2. Computer language	14
3. Troubleshooting	9
4. Communication skills	3
5. Relays (hands-on)	2
6. Wire wrapping	1
7. Office/business management	1
8. Inventory control	1
9. Customer relations	1
10. Motors Control	1
11. Power area (high)	1
12. Stress analysis	1
13. Schematics (more exposure)	1
14. Power supplies	1
15. Operational amps	1
16. Cost analysis	1
17. Printed circuit board construction	1
18. Drafting	1
19. Basic electronics	1

Question #2 -- Were there any skills you learned that weren't on the list that are important to your job?

Table 82

<u>Skills</u>	<u>Number of Responses</u>
1. Troubleshooting	1
2. Radar	1
3. Computer software Training Fortran 8080 language	1
4. Programming computers	1
5. Technical report writing	1
6. Job orientation (resume and job interviewing)	1

Question #3 -- Did you check any primary area with no knowledge necessary? If so, do you feel that area still should be required?

Table 83

<u>No Knowledge Necessary</u>	<u>Should that area still be required?</u>	
	<u>Yes</u>	<u>No</u>
33	31	2

Question #4 -- What program modifications can you think of that would improve the program?

Table 84

<u>Modification</u>	<u>Number of Responses</u>
1. Additional training in troubleshooting	17
2. Additional training in micro processors	15
3. Additional time on logic	11
4. More instruction on computer programming	6
5. More lab time	5
6. Greater emphasis on planning labs	3
7. Incorporate more schematics in training	3
8. More instruction on electronic communications	3
9. More time on motors/controllers	2
10. Expand projects	2
11. More exposure to test equipment	2
12. More time on IC's	2
13. Fab tech should be required	2
14. Combine AC/DC machinery into one course	2
15. Drafting taught on a higher level	2

Question #5 -- General Comments

Table 85

	<u>Number of Responses</u>	
1. Drop some courses in general education and use additional time teaching electronic courses.	a) Economics	6
	b) Social Institutions	4
	c) Psychology	3
	d) English	1
	e) Sociology	1
2. Add or expand some courses in general education	a) Communication Skills	6
	b) Math	2
	c) Management	1
	d) Inventory Control	1
	e) Human Relations	1
	f) Chemistry	1
	g) Physics	1
3. General education courses good - keep them all.	4	
4. Teaching outdated material	1	
5. Better program scheduling	1	
6. Do not let people without prerequisites take the course until prerequisites are met.	1	

Chapter IX

Survey Questions

In addition to rating the competencies, both the graduate and employer survey instrument asked three questions.

- 1) Overall, how qualified were you (were the Wisconsin Technical trained people) trained in the area of job-entry skills? See Table 86 for results.
- 2) In what two areas do you feel (do you feel the Wisconsin Electronic Technician was) the best prepared? See Table 87 for results.
- 3) In what two areas do you feel (do you feel the Wisconsin Electronic Technician was) the least adequately prepared? See Table 88 for results.

Summary of Questions

The results of Question One show that all three groups overwhelmingly rated the training received in the Wisconsin Technical schools as qualifying or well qualifying the graduates with job-entry skills. In addition, the employers who didn't want to take the time to fill out the survey did say that the graduates they knew were well qualified.

The results of Question Two show fair agreement between the three groups for three areas (DC, AC and Transistor Theory). For the rest of the areas, there is some disagreement.

The results of Question Three show mostly disagreement between the three groups for all areas. But, each group did point out strongly some areas of weakness.

Some areas appeared in the results for both Questions Two and Three. This is possibly due to the difference in curriculum (See Chapter X for a curriculum comparison.)

Table 86

Overall, how qualified were you (were the Wisconsin Technical trained people) trained in the area of job-entry skills?

	Number of Responses		
	<u>Field*</u>	<u>Related**</u>	<u>Employer</u>
Unqualified	3	1	0
Qualified	22	8	10
Well Qualified	11	4	5

*Graduates working as Electronic Technicians.

**Graduates working in a related field.

Table 87

In what two areas do you feel (do you feel the Wisconsin Electronic Technician was) the best prepared?

Number of Responses

	<u>Field*</u>	<u>Related**</u>	<u>Employer</u>
<u>Areas that Cover the Whole Program</u>			
Troubleshooting	1	-	-
Reading Blueprints (Schematics)	1	1	-
Basic Metering (reading)	1	-	1
Use of Test Equipment	1	-	1
Tube Type Equipment	1	-	-
<u>Areas that are Related to Basic Courses</u>			
Fabrication	1	-	3
Principles of Direct Current	9	3	5
Principles of Alternating Current	9	4	4
Transistor Theory	16	6	6
Analog Circuits	-	1	-
<u>Areas that are Related to Advanced Courses</u>			
Circuit Analysis	-	2	-
AC-DC Machinery	5	1	-
Industrial Electronics	2	2	-
IC Circuits	2	-	-
Digital Electronics	12	1	3
Programming	4	-	-
Microprocessor	-	-	1
Radio Communication	-	1	-
<u>Areas that are Related to General Education or Special</u>			
Communication (English)	1	5	-
Report Writing	-	-	1
Physics	-	1	-
Industrial Management	-	1	-

*Graduates working as Electronic Technicians

**Graduates working in related field.

Table 88

In what two areas do you feel (do you feel the Wisconsin Electronic Technician was) the least adequately prepared?

Number of Responses			
	<u>Field*</u>	<u>Related**</u>	<u>Employer</u>
<u>Areas that Cover the Whole Program</u>			
Troubleshooting	10	1	4
Drafting	1	2	-
Use of Oscilloscope	1	-	-
Soldering	-	-	1
Use of test equipment	-	-	2
Calibration	-	-	1
<u>Areas that are Related to Basic Courses</u>			
Fabrication	5	1	-
Dielectrics	1	-	-
AC Measurements	-	-	1
Transistor Theory	-	1	-
Analog Circuits	2	-	1
<u>Areas that are Related to Advanced Courses</u>			
AC-DC Machinery	4	1	-
Motor Control	3	1	-
Industrial Electronics	4	2	-
Logic	-	3	-
Digital Principles	6	-	-
Communication Theory	-	3	-
Computer Programming	4	-	-
Microprocessor	1	6	5
Radio Communication	9	1	1
RF Transmission Lines	1	-	-
High Voltage	1	-	2
Design	1	-	-
<u>Areas that are Related to General Education or Special</u>			
Communication (English)	1	-	-
Pneumatics	1	-	-
Heat Induction	1	-	-
Radar	-	1	-
Photo-electric Devices	-	1	-
Quality Control	-	-	1
Machine Tool	-	-	1
Process Control	-	-	1
Servo Systems	-	1	-
Mechanical Technology	-	-	1

*Graduates working as Electronic Technicians.

**Graduates working in related field.

Chapter X

Comparison of School Curriculum

A recent catalog was obtained for each school so that the curriculum could be compared. The course descriptions were compared to the course descriptions for Gateway Technical Institute's curriculum. Then the credits for each course for each school were interpolated as shown in Table 89. The author accepts any mistakes for misinterpretation. Each school was assigned an arbitrary number since it wasn't an objective of this research to point out any one school's strengths or weaknesses.

Summary of Curriculum Comparison

Table 89 shows that there are many courses in common to most of the schools. Some schools may require them and others offer them as an elective. Also, the credits may vary depending upon the emphasis.

There are some courses that appear to be left out of the curriculum at some schools notably: Fabrication, Drafting, AC-DC Machinery, Microprocessor and Computer courses. Some schools may not feel a need for these courses. No school can be expected to be everything to everyone.

Table 89

Credits in Program Courses

School Number	1	2	3	4	5	6	7	8	9	10
<u>Basic Courses</u>										
Fabrication	3	3	-	3	3	-	-	3	2	2
DC Principles	4	4	4	2	4	6	4	2	5	4
AC Principles	4	4	4	6	6	6	5	3	4	4
Electronics/ Principles	4	5	4	4	3	5	5	4	3	4
Drafting	2	-	2	3	-	E	2	2	-	-
<u>Advanced Courses</u>										
Electronic Circuits	4	4	8	5	6	5	-	7	4	4
AC-DC Machinery	4	-	-	7	4	-	3	-	-	6
Electronic Projects	4	3	7	3	6	2	6	9	-	4
Industrial Electronics	4	4	4	6	E	-	9	3	4	7
Microprocessor	2	4	E	-	-	-	-	E	-	3
Radio Communication	E	4	-	6	4	E	4	E	5	4
Computer Logic	E	4	2	3	4	4	-	-	-	-
Digital Circuits	E	-	4	-	E	E	-	-	4	-
Bio-medical	-	-	-	-	-	E	-	-	-	-
High Power	-	-	-	-	-	E	-	-	-	-
Computer Language	-	-	-	-	-	-	-	-	2	2
Required	35	39	39	44	38	28	38	33	37	44
Electives	6	-	6	6	2	4-6	-	6	-	-

E indicates a possible elective.

Chapter XI

Advice to Other Researchers

A project of this nature should be started very early in the calendar year because of the time involved: in getting graduate names, addresses and phone numbers, developing and printing and distributing and follow up of the instrument and letters. Summer is also a bad time to try to contact people because of vacations. The summer could be used for analyzing and writing report.

More details about some of the problem areas follow:

A) Calendar time

1. April 12, 1979 contacted about project.
2. May 15, 1979 each school was contacted and asked to provide a graduate list.
3. May 16, 1979 received decision about survey instrument to be used.
4. June 6, 1979 obtained instrument from print shop.
5. June 12, 1979 met with State Board representative and other concerned parties for final review of instrument and letters.
6. June 21, 1979 sent out first graduate survey instrument.
7. June 14-21, 1979 phone number search.
8. June 26-August 8, 1979 interviews conducted.
9. July 2, 1979 received graduate list from 10th school.
10. July 2, 1979 sent out first employer survey instrument.
11. July 10, 1979 first phone reminder to employers.
12. July 11, 1979 sent out last graduate survey instrument.
13. September 13, 1979 received last employer response.
14. September 18, 1979 received last graduate response.

B) Mail Problems

1. Wrong address (returned with no forwarding address).
2. Some forwarded of which the post office notified us of some but not all.
3. Tried to get phone numbers for a follow up with mixed success.

C) Phone Number Problems

1. No phone number in phone book under name and address given.
2. Operator couldn't locate numbers.
3. Operator can only give out two numbers/call.
4. No answer at some numbers (day or evening).

D) Budget -- The original budget contained:

1. Principle Investigator - eight weeks x \$180/week=\$1,440
2. Instructor assistance - \$8.84/hour x 165 hours=\$1,374
3. Interviewer - \$3.00/hour x 100 hours=\$300
4. Fringe Benefits - \$407
5. Travel - \$350
6. Duplication \$100
7. Phone - \$150

The budget should be increased at least for the principle investigator, phone and duplication. It should also be expanded to include secretarial costs.

E) General

1. People on vacation - had to call back.
2. Instrument length too long (a common complaint of graduates but even more so of employers).

Chapter XII

Conclusions and Recommendations

The purpose of this study was to assess the relationship between the competencies taught in the Wisconsin Technical Electronic Technology programs and the competencies needed on the job.

It was felt that the best source of information regarding the effectiveness of the Electronic Technology program curriculum would be graduates of the program and employers of graduates. Therefore, the findings of the study are based on data received from these two sources. To meet the purpose of the study, both groups were asked to react to a competency list and to answer questions regarding the Electronic Technology program. Because it was felt that a totally objective survey instrument would not give a complete picture of the Electronic Technician's responsibilities, the survey population was asked about degree of qualification, two areas of best preparation and two areas of least preparation.

Conclusions

In reviewing the findings with respect to the objectives of the study, the following conclusions are made. These conclusions are based on the cumulative responses of graduates from the Electronic Technology programs of the ten schools taking part in this study and their respective employers.

1. Importance on Job (reference summaries for Chapters III, IV, V, VI and VII)
 - a) All three groups (graduates working in the field, graduates working in a related field and employers) indicate that all of the competencies listed have some importance on the job. No competency had a mean less than 1.40 by any group.
 - b) Each group had a good agreement among themselves about the importance of each competency as indicated by no standard deviation greater than 1.81.
 - c) There is a big difference of opinion in both groups of graduates about the importance of the Microprocessor course. This may be due to the wide variety of jobs the graduates go into.
 - d) Employers rated the importance of the competencies higher than the graduates. This is shown by the employers having a higher mean on 88 of the competencies.
 - e) The graduates working in the field and the employers agree pretty well on 90% of the competencies with a difference of mean less than 0.70.

- f) The graduates and employers rankings within each course agree pretty well except for a few exceptions. Since there are an average of 12 competencies for each course, any competency with a difference of six or greater in ranking may be an area for concern. The following competencies meet this criterion.

<u>Table</u>	<u>Graduate Ranking</u>	<u>Employer Ranking</u>	<u>Competency</u>
40	14	4.5	Use test equipment to calibrate electronic equipment.
34	3	10.0	Verify the effect of capacitance in an AC circuit.
34	10	3	Measure the impedance, phase angle, power and current in parallel circuits.
37	12.5	6	Record the advantages and disadvantages of several types of single phase motors.

- g) Graduates working in the field rated the competencies higher than the graduates working in a related field. Those working in the field rated all aspects of troubleshooting higher.

2. Preparation at School (reference summaries for Chapters III, IV, V, VI and VII)

- a) All three groups rated the preparation at school as good. No competency has a mean less than 2.00 by any group.
- b) All three groups indicate that the best preparation was in the Principles of DC course.
- c) The graduates working in a related field indicate their poorest preparation was in the Microprocessor course. This could be due to a lack of training or the introduction of this course after a person has graduated.
- d) The employers indicate the poorest preparation in the AC-DC Machinery course. This may be because some schools don't teach this course.
- e) The highest difference in means was for the AC-DC Machinery course with the graduates rating their preparation higher than the employer did.
- f) The graduates working in the field and the employers agree pretty well on 90% of the competencies with a difference of mean less than 0.80.

- g) The graduates and employers rankings within each course agree pretty well except for a few exceptions. Since there are an average of 12 competencies for each course, any competency with a difference of 7.5 or greater in ranking may be an area for concern. A higher number was used here because it is felt that the employer may not be familiar with all of the graduates preparation at school. The following competencies meet this criterion.

<u>Table</u>	<u>Graduate Ranking</u>	<u>Employer Ranking</u>	<u>Competency</u>
45	2	13	Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.
45	11	3	Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.
45	9.5	1.5	Construct, analyze and troubleshoot small signal transistor amplifier.
45	9.5	1.5	Construct, analyze and troubleshoot power transistor amplifier.
46	2	9.5	Apply the principles of feedback to oscillators.
47	11.5	4.0	Set up and verify the load characteristics of a polyphase motor.
47	11.5	4.0	Test the performance of different three phase connections.
49	1	8.5	Use the UJT as a triggering device.

- h) Graduates working in a related field rated the competencies higher than the graduates working in the field for 94 competencies. This was particularly true for the Principles of DC and the Fabrication courses.

3. Adequacy of Instructional Equipment (reference summaries for Chapters III, IV and VII)

- a) Both groups of graduates rated the adequacy of equipment as good. No competency has a mean less than 1.50 by either group.
- b) The graduates working in a related field rated the equipment better than the graduates working in the field. The graduates in the related field had a higher mean for 83 of the competencies.

4. Interview Results (reference Chapter VIII)

- a) Many of the graduates indicated a lack of training in micro-processor skills, computer language and troubleshooting. The first two may indicate the lack of these courses at the time they were in school. The last may be due to the fact that no school has a course titled Troubleshooting and the lack of realizing when they are doing troubleshooting.

- b) Even though the graduates rated some of the competencies low for Importance on Job, they felt that there is a purpose in teaching them and should be retained.
- c) The graduates seem to have mixed feelings about the General Education courses. Some thought that certain courses should be expanded, others thought the same courses should be reduced and others thought they should remain the same.

5. Survey Questions Results (reference Chapter IX)

- a) All of the schools should be proud of their Electronic Technology program, since nearly all of the graduates and all of the employers rated the graduates' qualifications as qualified or well qualified.
- b) For the areas of best preparation, the graduates and employers agreed on three areas: Principles of Direct Current, Principles of Alternating Current and Transistor Theory. There was a disagreement about all of the other areas mentioned.
- c) For the areas of least adequate preparation, there were many areas given but very little agreement.
- d) Some areas appear in both the best and least adequately prepared tables. This might indicate a difference in the curriculum or the emphasis at the different school.

6. Curriculum (reference Chapter X)

- a) If a graduate took all of the required courses and program electives, then the curriculums are quite similar.
- b) Some of the schools don't offer the following as separate courses: Fabrication, Drafting, AC-DC Machinery, Micro-processor and Computer courses. This point is brought out because these courses have come up throughout this study.

Recommendations

Based on the results of this study, the following recommendations are made:

1. Each school should give one or more instructors a reduced load and time off to contact potential employers within a certain range of their school.

This recommendation is made since there seems to be a number of differences of opinion between the graduates and the employers about the importance and preparation of several competencies, relative importance of theory vs. lab time, and relative importance of general education, particularly math, english and report writing.

2. The curriculum committee for each school should review the following:

- a) The graduate and employer responses for the least importance on the job (summary Chapter III and Chapter V or chapter tables) to see if these competencies may be dropped.
- b) The graduate and employer responses for the poorest preparation at school (summary Chapter III and V or chapter tables) to see if the preparation could be improved at their school.
- c) Check to see how their school is doing in the following areas: fabrication, drafting, machinery and/or motor control, microprocessor skills, computer language, troubleshooting. These areas were rated high in importance and low in preparation from time to time throughout this study.
- d) Find some way to impress upon students the importance of general education particularly math, english and report writing in order to be a well rounded technician.

Appendix

APPENDIX A - Survey Cover Letter - Graduate Mail



District Office
Kenosha Campus
3520 - 30th Avenue
Kenosha, WI 53141
Phone (414) 656-6900

Racine Campus
1001 South Main Street
Racine, WI 53403
Phone (414) 637-9881

Elkhorn Campus
E. Centralia St & Hwy 14
Elkhorn, WI 53121
Phone (414) 723-5390

WGTD - FM 911
352G - 30th Avenue
Kenosha, WI 53141
Phone (414) 552-9483

Kath W. Stoebe
District Director & President

Dear Graduate:

Gateway is conducting an approved statewide survey to determine if the present Electronic programs are fulfilling the needs of industry in preparing people for employment as Electronic Technicians.

As a graduate of an Electronic Technology Program, your assistance and expertise is of great value to this study. Your participation by completing and returning the enclosed form will be helping your school improve the actual training of Electronic Technicians.

Please return the enclosed form today in the self-addressed, stamped envelope. All information will be strictly confidential, and names will not be used in the final report.

Sincerely,

Melvin M. May
Melvin M. May
Project Coordinator

ts

Enclosures

APPENDIX B - Survey Cover Letter - Graduate Interview



District Office
Kenosha Campus
3520 - 30th Avenue
Kenosha, WI 53141
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Racine Campus
1001 South Main Street
Racine, WI 53403
Phone (414) 837-9881

Elkhorn Campus
E Centralia St. & Hwy H
Elkhorn, WI 53121
Phone (414) 723-5390

WGTD - FM 91.1
3520 - 30th Avenue
Kenosha, WI 53141
Phone (414) 552-9483

Koeth W. Stoehr
District Director & President

Dear Graduate:

Gateway is conducting an approved statewide survey to determine if the present Electronic programs are fulfilling the needs of industry in preparing people for employment as Electronic technicians.

As a graduate of an Electronic Technology Program, your assistance and expertise is of great value to this study. Your participation by consenting to an interview will be helping your school improve the actual training of Electronic Technicians.

Please look over the enclosed questionnaire prior to our interview. This will expedite the interview and conserve your time.

Sincerely,

Melvin M. May
Melvin M. May
Project Coordinator

ts

Enclosure

APPENDIX C - Graduate Survey Instrument

Electronic Technology Program
Statewide Study 1979
Employee Survey

No _____

School attended:

Blackhawk _____

Fox Valley _____

Gateway _____

Indianhead _____

Lakeshore _____

Madison _____

Milwaukee _____

North Central _____

VTAE District #1 _____

Waukesha _____

Western Wisconsin _____

Year of graduation _____

Male _____

Female _____

Years employed as Electronic Technician _____

Are you now working as an Electronic Technician? Yes _____ No _____

If not, is your job related to your Electronic Technology training?

Yes _____ No _____

Present job title _____

Briefly list duties _____

Permission to contact employer

____ Yes, you may contact my employer for a personal or phone interview.
Person to contact is: _____

____ Yes, you may contact my employer with a mail questionnaire.
Person to contact is: _____

____ No, you may not contact my employer.

Company _____

Address _____

City _____ State _____ Zip _____

Following is a list of job skills used by Electronic Technicians. There are three different categories for each task listed:

- 1) How important is this skill in the performance of your job?
- 2) How well do you feel your school prepared you to perform this task?
- 3) Was the equipment at your school adequate to train you in this area?

Please circle the number in each category, for each task listed, which best expresses your opinion.

If you are not working as an Electronic Technician, please complete the following as it best applies to your job.

How important is this skill in the performance of your job?

No
Preparation
adequate

Some
Preparation
adequate

Knowledge
adequate

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

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1 2 3 4 5

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the principles of the primary cells and secondary cells.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenin's theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

How well do you feel your school prepared you to perform this task?

Unprepared

Adequate preparation

Excellent preparation

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

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1 2 3 4 5

Was the equipment at your school adequate to train you in this area?

Poor

Satisfactory

Excellent

1 2 3

1 2 3

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1 2 3

How important is this skill in the performance of your job?

No knowledge necessary
Some knowledge needed
Knowledge essential

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

Fabrication Techniques (Continued)

Select proper printed circuit board materials.

Solder and desolder printed circuit boards, interconnection wires.

Select printed circuit hardware for a given project.

Select chassis hardware for a given project.

Select proper hook-up wires and interconnection techniques.

Assemble, interconnect, and test cables and connectors.

Electrical Drafting

Identify standard electronic symbols and diagrams.

Prepare electronic schematic.

Prepare all drawings necessary for plan and manufacture of printed circuit board.

Prepare block diagrams for electronic and computer systems.

Use drafting equipment and procedures to represent electronics data.

Use standard abbreviations, component references, fasteners and military and engineering standards in electronics work.

Principles of Alternating Current

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

Define the characteristics of AC currents and voltages.

Calculate the effect of capacitance in an AC circuit.

Verify the effect of capacitance in an AC circuit.

Calculate the effect of inductance in an AC circuit.

Verify the effect of inductance in an AC circuit.

Calculate the impedance, phase angle, power and voltage in series circuits.

Measure the impedance, phase angle, power and voltage in series circuits.

Calculate the impedance, phase angle, power and current in parallel circuits.

Measure the impedance, phase angle, power and current in parallel circuits.

Solve problems involving AC networks.

Solve problems involving three phase systems.

Principles of Electronics

Identify the characteristics of semiconductors and properties of PN junctions.

How well do you feel your school prepared you to perform this task?

Unprepared

1 2 3 4 5

1 2 3 4 5

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Was the equipment at your school adequate to train you in this area?

Poor

1 2 3

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1 2 3

How important is this skill in the performance of your job?

How well do you feel your school prepared you to perform this task?

Was the equipment at your school adequate to train you in this area?

No knowledge necessary
Some knowledge needed
Knowledge essential

Unprepared
Adequate preparation
Excellent preparation
Poor
Satisfactory
Excellent

Principles of Electronics (Continued)

1	2	3	4	5	Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.	1	2	3	4	5	1	2	3
1	2	3	4	5	Evaluate device parameters of diodes and transistors.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct, analyze and troubleshoot small-signal transistor amplifier.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct, analyze and troubleshoot power transistor amplifier.	1	2	3	4	5	1	2	3
1	2	3	4	5	Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate and measure the input impedance and output impedance of a given transistor amplifier.	1	2	3	4	5	1	2	3
1	2	3	4	5	Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.	1	2	3	4	5	1	2	3
1	2	3	4	5	Model a transistor circuit for AC or DC in order to obtain the transfer function.	1	2	3	4	5	1	2	3
1	2	3	4	5	Apply the load line technique and the operating point to classify the amplifier operation.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct and analyze the varied interstage couplings to insure the maximum power transfer.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate the cascaded amplifier gain.	1	2	3	4	5	1	2	3
1	2	3	4	5	Measure and calculate the frequency band-width of a transistor amplifier.	1	2	3	4	5	1	2	3
1	2	3	4	5	Measure the temperature effect on transistor amplifiers operation.	1	2	3	4	5	1	2	3

Electronic Circuits

1	2	3	4	5	Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct, analyze and troubleshoot the field-effect transistor amplifier.	1	2	3	4	5	1	2	3
1	2	3	4	5	Simplify circuits using decibels and Miller's theorem.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate and test frequency effects on amplifier performance.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct, analyze and troubleshoot differential amplifier circuits.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct, analyze and troubleshoot operational amplifier circuits.	1	2	3	4	5	1	2	3
1	2	3	4	5	Apply the principles of feedback to amplifiers.	1	2	3	4	5	1	2	3
1	2	3	4	5	Apply the principles of feedback to oscillators.	1	2	3	4	5	1	2	3
1	2	3	4	5	Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.	1	2	3	4	5	1	2	3
1	2	3	4	5	Find the harmonics present in a mixer.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate and test the effects of modulation.	1	2	3	4	5	1	2	3
1	2	3	4	5	Construct, analyze and troubleshoot voltage regulators.	1	2	3	4	5	1	2	3

AC-DC Machinery

1	2	3	4	5	Analyze the operation of DC generators.	1	2	3	4	5	1	2	3
1	2	3	4	5	Study and use the conventions for generators and motors.	1	2	3	4	5	1	2	3

How important is this skill in the performance of your job?

1 2 3 4 5
Not at all important
Some knowledge
less needed
Knowledge
essential

How well do you feel your school prepared you to perform this task?

Unprepared
Adequate
preparation
Excellent
Preparation

Was the equipment at your school adequate to train you in this area?

Poor
Satisfactory
Excellent

AC-DC Machinery (Continued)

1	2	3	4	5	Test the performance of different types of DC motors.	1	2	3	4	5	1	2	3
1	2	3	4	5	Analyze the operation of AC generators.	1	2	3	4	5	1	2	3
1	2	3	4	5	Set up and verify the load characteristics of a polyphase motor.	1	2	3	4	5	1	2	3
1	2	3	4	5	Verify the losses and efficiency of a motor by different methods.	1	2	3	4	5	1	2	3
1	2	3	4	5	Record the advantages and disadvantages of several types of single phase motors.	1	2	3	4	5	1	2	3
1	2	3	4	5	Set up and verify the operating characteristics of different types of synchros.	1	2	3	4	5	1	2	3
1	2	3	4	5	Verify the polarity and load performance of a transformer.	1	2	3	4	5	1	2	3
1	2	3	4	5	Verify the transformer losses and equivalent circuit.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate transformer efficiency and voltage regulation.	1	2	3	4	5	1	2	3
1	2	3	4	5	Test the performance of different three phase connections.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate the mechanical characteristics of a servo system.	1	2	3	4	5	1	2	3

Electronic Projects

1	2	3	4	5	Connect, evaluate and troubleshoot linear integrated circuits.	1	2	3	4	5	1	2	3
1	2	3	4	5	Identify integrated-circuit logic and memories.	1	2	3	4	5	1	2	3
1	2	3	4	5	Connect, evaluate and troubleshoot digital integrated circuit sub-systems.	1	2	3	4	5	1	2	3
1	2	3	4	5	Design, construct and troubleshoot electronic projects.	1	2	3	4	5	1	2	3
1	2	3	4	5	Use the guidelines of technical report writing to write project reports.	1	2	3	4	5	1	2	3
1	2	3	4	5	Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.	1	2	3	4	5	1	2	3
1	2	3	4	5	Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).	1	2	3	4	5	1	2	3
1	2	3	4	5	Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.	1	2	3	4	5	1	2	3
1	2	3	4	5	Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.	1	2	3	4	5	1	2	3
1	2	3	4	5	Connect and test A/D and D/A converters.	1	2	3	4	5	1	2	3
1	2	3	4	5	Connect and test the phase lock loop circuits.	1	2	3	4	5	1	2	3
1	2	3	4	5	Connect and analyze active filters and phase-shifters.	1	2	3	4	5	1	2	3

Industrial Electronics

1	2	3	4	5	Construct solid state controls.	1	2	3	4	5	1	2	3
1	2	3	4	5	Calculate and test phase shift control circuits.	1	2	3	4	5	1	2	3
1	2	3	4	5	Set up and test a SCR with AC bias control.	1	2	3	4	5	1	2	3

knowledge
essential

Unprepared	Adequate preparation	Excellent preparation
1. <i>Unprepared</i> 2. <i>Unprepared</i> 3. <i>Unprepared</i> 4. <i>Unprepared</i> 5. <i>Unprepared</i> 6. <i>Unprepared</i> 7. <i>Unprepared</i> 8. <i>Unprepared</i> 9. <i>Unprepared</i> 10. <i>Unprepared</i>	1. <i>Adequate preparation</i> 2. <i>Adequate preparation</i> 3. <i>Adequate preparation</i> 4. <i>Adequate preparation</i> 5. <i>Adequate preparation</i> 6. <i>Adequate preparation</i> 7. <i>Adequate preparation</i> 8. <i>Adequate preparation</i> 9. <i>Adequate preparation</i> 10. <i>Adequate preparation</i>	1. <i>Excellent preparation</i> 2. <i>Excellent preparation</i> 3. <i>Excellent preparation</i> 4. <i>Excellent preparation</i> 5. <i>Excellent preparation</i> 6. <i>Excellent preparation</i> 7. <i>Excellent preparation</i> 8. <i>Excellent preparation</i> 9. <i>Excellent preparation</i> 10. <i>Excellent preparation</i>

Poor
Satisfactory
Excellent

- Set up and test the response of photoelectric devices.
- Set up and test the photoelectric control of a SCR.
- Test different types of relay circuits.
- Test different types of timing circuits.
- Set up and test delay relay circuit.
- Use the UJT as a triggering device.
- Graph curve of variable reluctance phase shift circuit
- Set up and test different motor control circuits.
- Set up and test different servo systems.

- Identify the functions and applications of a digital computer.
- Apply the principles of Boolean Algebra to the digital circuit.
- Connect, test and troubleshoot logic circuits.
- Connect, test and troubleshoot computer control circuits.
- Connect, test and troubleshoot computer memory circuits.
- Develop, load and run programs on a minicomputer or a microcomputer.
- Identify digital codes and mnemonic codes.
- Describe the architecture of microprocessor and micro-computer.
- Interface microprocessor with I/O.
- Write, debug and run micro-computer programs.
- Use control bus for external controllers.
- Use standard test equipment and procedure to check performance of electronics system.
- Use test equipment to calibrate electronic equipment.
- Use test equipment to troubleshoot the malfunctions of electronic equipment.

- Apply FCC rules and regulations to radio communications.
- Align IF amplifiers and RF power amplifiers.
- Connect, evaluate and troubleshoot amplitude and frequency modulators.
- Connect, evaluate and troubleshoot Foster-Seeley discriminator, ratio detector, and quadrature detector.
- Connect and align RF tuner.
- Connect, evaluate and troubleshoot the balanced modulator.
- Identify the principles of telemetry and multiplexer in the industrial controls.
- Operate, monitor and align a transmitter.

Overall, how qualified were you trained in the area of job-entry skills:

Unqualified _____

Qualified _____

Well Qualified _____

In what two areas do you feel the best prepared?

In what two areas do you feel the least adequately prepared?

129/a

APPENDIX D - Survey Cover Letter - Employer



District Office
Kenosha Campus
3520 - 30th Avenue
Kenosha, WI 53141
Phone (414) 656-6900

Racine Campus
1001 South Main Street
Racine, WI 53403
Phone (414) 637-9881

Elkhorn Campus
E Centralia St. & Hwy. H
Elkhorn, WI 53121
Phone (414) 723-5390

WGTD - FM 91.1
3520 - 30th Avenue
Kenosha, WI 53141
Phone (414) 552-9483

Koith W. Storck
District Director & President

Your name has been referred to us as a participant in a statewide approved survey of industrial establishments that have employed Electronic Technicians from two-year Associate Degree programs in the state of Wisconsin. The results of the survey are being prepared for the State Board of Vocational, Technical and Adult Education for curriculum improvement.

The purpose of the survey is to obtain information which would give impetus for possible curriculum changes and to determine if our present programs are meeting the needs of employers. Ultimately, we shall provide you, as the employer, with better qualified technicians.

Your participation by completing and returning the enclosed form will be helping your local technical school to improve its training program.

Any information you provide will be strictly confidential; no names will be used in the study report.

Sincerely,

Melvin M. May
Melvin M. May
Project Coordinator

ts

Enclosures

APPENDIX E - Employer Instrument

Electronic Technology Program
Statewide Study 1979
Employer Survey

No _____

Following is a list of job skills used by Electronic Technicians. There are three different categories for each task listed:

- 1) How important is this skill to the function of your Electronic Technicians?
- 2) How well do you feel the graduate was prepared to perform this task?

Please circle the number in each category, for each task listed, which best expresses your opinion.

How important is this skill
to the function of your
Electronic Technicians?

No Knowledge necessary	Some know- ledge needed	Knowledge essential
1	2	3
4	5	

How well do you feel the
graduate was prepared to
perform this task?

Unprepared	Adequate preparation	Excellent preparation
1	2	3
4	5	

Principles of Direct Current

Identify components by conventional methods such as symbols, specifications, pictures, color, code, etc.

Define electrical quantities such as potential, current, resistance, conductance, power and energy.

Calculate and verify unknown voltage, current, resistance or power in simple circuits using Ohm's Law.

Verify series and parallel circuit operation using Kirchoff's Law.

Calculate and verify series-parallel circuits using network theorems.

Design different meters using a DC meter movement.

Identify the effects of capacitance and inductance in DC.

Apply voltage divider rule and current divider rule to circuit analysis.

Describe the properties of permanent magnetism and electromagnetism.

Solve magnetic circuits to find required current and turns to build up a magnetic field strength, given permeability, dimensions and types of cores.

Calculate single-time constant circuit and select circuit components to obtain a specific time constant.

Apply Thevenins theorem, Norton's theorem, Delta-wye transformation and maximum power transfer theorem to DC circuit analysis.

Describe the temperature coefficient of resistance and apply it to calculate resistance at a temperature different from reference temperature.

Fabrication Techniques

Identify and practice safety procedures in the laboratory.

Mount and connect electrical components by soldering, splicing, cabling, breadboarding and wire-wrapping.

Measure, layout and fabricate chassis for the electronic equipment.

Layout the artwork, select and fabricate the printed circuit board.

Select and use hand tools and hardware for electronic assembly.

How important is this skill
to the function of your
Electronic Technicians?

How well do you feel the
graduate was prepared to
perform this task?

No knowledge
necessary

Some know-
ledge needed

Knowledge
essential

Unprepared

Adequate
preparation

Excellent
preparation

Fabrication Techniques (Continued)

1 2 3 4 5

Select proper printed circuit board materials.

1 2 3 4 5

1 2 3 4 5

Solder and desolder printed circuit boards, interconnection wires.

1 2 3 4 5

1 2 3 4 5

Select printed circuit hardware for a given project.

1 2 3 4 5

1 2 3 4 5

Select chassis hardware for a given project.

1 2 3 4 5

1 2 3 4 5

Select proper hook-up wires and interconnection techniques.

1 2 3 4 5

1 2 3 4 5

Assemble, interconnect, and test cables and connectors.

1 2 3 4 5

Electrical Drafting

1 2 3 4 5

Identify standard electronic symbols and diagrams.

1 2 3 4 5

1 2 3 4 5

Prepare electronic schematic.

1 2 3 4 5

1 2 3 4 5

Prepare all drawings necessary for plan and manufacture of printed circuit board.

1 2 3 4 5

1 2 3 4 5

Prepare block diagrams for electronic and computer systems.

1 2 3 4 5

1 2 3 4 5

Use drafting equipment and procedures to represent electronics data.

1 2 3 4 5

1 2 3 4 5

Use standard abbreviations, component references, fasteners and military and engineering standards in electronics work.

1 2 3 4 5

Principles of Alternating Current

1 2 3 4 5

Identify and use the basic controls of an oscilloscope and set up and display various electrical wave forms.

1 2 3 4 5

1 2 3 4 5

Define the characteristics of AC currents and voltages.

1 2 3 4 5

1 2 3 4 5

Calculate the effect of capacitance in an AC circuit.

1 2 3 4 5

1 2 3 4 5

Verify the effect of capacitance in an AC circuit.

1 2 3 4 5

1 2 3 4 5

Calculate the effect of inductance in an AC circuit.

1 2 3 4 5

1 2 3 4 5

Verify the effect of inductance in an AC circuit.

1 2 3 4 5

1 2 3 4 5

Calculate the impedance, phase angle, power and voltage in series circuits.

1 2 3 4 5

1 2 3 4 5

Measure the impedance, phase angle, power and voltage in series circuits.

1 2 3 4 5

1 2 3 4 5

Calculate the impedance, phase angle, power and current in parallel circuits.

1 2 3 4 5

1 2 3 4 5

Measure the impedance, phase angle, power and current in parallel circuits.

1 2 3 4 5

1 2 3 4 5

Solve problems involving AC networks.

1 2 3 4 5

1 2 3 4 5

Solve problems involving three phase systems.

1 2 3 4 5

Principles of Electronics

1 2 3 4 5

Identify the characteristics of semiconductors and properties of PN junctions.

1 2 3 4 5

No knowledge necessary

Unprepared	Adequate preparation	Excellent preparation
1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30
31	32	33
34	35	36
37	38	39
40	41	42
43	44	45
46	47	48
49	50	51
52	53	54
55	56	57
58	59	60
61	62	63
64	65	66
67	68	69
70	71	72
73	74	75
76	77	78
79	80	81
82	83	84
85	86	87
88	89	90
91	92	93
94	95	96
97	98	99
100	101	102

Breadboard, operate and troubleshoot the diode rectifier, diode limiter and diode clamper.

Construct, analyze and troubleshoot small-signal transistor amplifier

Apply Thevenin's theorem to analyze the transistor circuit in terms of current and voltage gain.

Operate a transistor tester and/or a curve tracer to obtain the electrical rating of diodes and transistors.

Apply the load line technique and the operating point to classify the amplifier operation.

Calculate the cascaded amplifier gain.

Measure the temperature effect on transistor amplifiers operation.

Identify the characteristics of the field-effect transistor and evaluate the device parameters using the transistor curve tracer.

Construct, analyze and troubleshoot the field-effect transistor amplifier.

Simplify circuits using decibels and Miller's theorem.

Calculate and test frequency effects on amplifier performance.

Construct, analyze and troubleshoot differential amplifier circuits.

Construct, analyze and troubleshoot operational amplifier circuits.

Apply the principles of feedback to amplifiers.

Apply the principles of feedback to oscillators.

Analyze the amplifier distortion with the distortion analyzer or spectrum analyzer.

Find the harmonics present in a mixer.

Calculate and test the effects of modulation.

Construct, analyze and troubleshoot voltage regulators.

Analyze the operation of DC generators.

Study and use the conventions for generators and motors.

How important is this skill
to the function of your
Electronic Technicians?

No knowledge necessary	Some know- ledge needed	Knowledge essential
---------------------------	----------------------------	------------------------

1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5

AC-DC Machinery (Continued)

Test the performance of different types of DC motors.

Analyze the operation of AC generators.

Set up and verify the load characteristics of a polyphase motor.

Verify the losses and efficiency of a motor by different methods.

Record the advantages and disadvantages of several types of single phase motors.

Set up and verify the operating characteristics of different types of synchros.

Verify the polarity and load performance of a transformer.

Verify the transformer losses and equivalent circuit.

Calculate transformer efficiency and voltage regulation.

Test the performance of different three phase connections.

Calculate the mechanical characteristics of a servo system.

Electronic Projects

1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
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1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5

Connect, evaluate and troubleshoot linear integrated circuits.

Identify integrated-circuit logic and memories.

Connect, evaluate and troubleshoot digital integrated circuit sub-systems.

Design, construct and troubleshoot electronic projects.

Use the guidelines of technical report writing to write project reports.

Use the transistor-transistor logic, CMOS logic or emitter coupled logic to implement a logic function.

Troubleshoot digital circuits using an oscilloscope and/or a logic state analyzer (data domain oscilloscope).

Connect and troubleshoot light sources and displays using light-emitting diodes, semi-conductor injection lasers, and liquid-crystal displays.

Connect and troubleshoot photodetectors and source detector combinations, such as photoconductors, photodiodes, solar cells, photo-transistors, photothyristors, and opto-isolators.

Connect and test A/D and D/A converters.

Connect and test the phase lock loop circuits.

Connect and analyze active filters and phase-shifters.

Industrial Electronics

1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5

Construct solid state controls.

Calculate and test phase shift control circuits.

Set up and test a SCR with AC bias control.

How well do you feel the
graduate was prepared to
perform this task?

Unprepared	Adequate preparation	Excellent Preparation
------------	-------------------------	--------------------------

1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
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1	2	3	4	5

1	2	3	4	5
1	2	3	4	5
1	2	3	4	5
1	2	3	4	5

Knowledge
essential

Unprepared		Adequate preparation		Excellent preparation
------------	--	-------------------------	--	--------------------------

- Set up and test the response of photoelectric devices.
- Set up and test the photoelectric control of a SCR.
- Test different types of relay circuits.
- Test different types of timing circuits.
- Set up and test delay relay circuit.
- Use the UJT as a triggering device.
- Graph curve of variable reluctance phase shift circuit.
- Set up and test different motor control circuits.
- Set up and test different servo systems.

- Identify the functions and applications of a digital computer.
- Apply the principles of Boolean Algebra to the digital circuit.
- Connect, test and troubleshoot logic circuits.
- Connect, test and troubleshoot computer control circuits.
- Connect, test and troubleshoot computer memory circuits.
- Develop, load and run programs on a minicomputer or a microcomputer.
- Identify digital codes and mnemonic codes.
- Describe the architecture of microprocessor and micro-computer.
- Interface microprocessor with I/O.
- Write, debug and run micro-computer programs.
- Use control bus for external controllers.
- Use standard test equipment and procedure to check performance of electronics system.
- Use test equipment to calibrate electronic equipment.
- Use test equipment to troubleshoot the malfunctions of electronic equipment.

Apply FCC rules and regulations to radio communications.	1	2	3	4	5
Align IF amplifiers and RF power amplifiers.	1	2	3	4	5
Connect, evaluate and troubleshoot amplitude and frequency modulators.	1	2	3	4	5
Connect, evaluate and troubleshoot Foster-Seeley discriminator, ratio detector, and quadrature detector.	1	2	3	4	5
Connect and align RF tuner.	1	2	3	4	5

How important is this skill
to the function of your
Electronic Technicians?

No knowledge necessary					
	1	2	3	4	5
Some know- ledge needed					
	1	2	3	4	5
Knowledge essential					
	1	2	3	4	5

Radio Communication (Continued)

Connect, evaluate and troubleshoot the balanced modulator.

Identify the principles of telemetry and multiplexer in the
industrial controls.

Operate, monitor and align a transmitter.

How well do you feel the
graduate was prepared to
perform this task?

Unprepared					
	1	2	3	4	5
Adequate preparation					
	1	2	3	4	5
Excellent preparation					
	1	2	3	4	5

Overall, how qualified were the Wisconsin Technical trained people in the area of job-entry skills.

Unqualified _____

Qualified _____

Well Qualified _____

In what two areas do you feel the Wisconsin Electronic Technician was best prepared?

In what two areas do you feel the Wisconsin Electronic Technician was least adequately prepared?

How important is this skill
to the function of your
Electronic Technicians?

How well do you feel the
graduate was prepared to
perform this task?

No knowledge
necessary

Some know-
ledge needed

Knowledge
essential

Unprepared

Adequate
preparation

Excellent
preparation

Industrial Electronics (Continued)

Set up and test the response of photoelectric devices.

Set up and test the photoelectric control of a SCR.

Test different types of relay circuits.

Test different types of timing circuits.

Set up and test delay relay circuit.

Use the UJT as a triggering device.

Graph curve of variable reluctance phase shift circuit.

Set up and test different motor control circuits.

Set up and test different servo systems.

Micro Computer

Identify the functions and applications of a digital computer.

Apply the principles of Boolean Algebra to the digital circuit.

Connect, test and troubleshoot logic circuits.

Connect, test and troubleshoot computer control circuits.

Connect, test and troubleshoot computer memory circuits.

Develop, load and run programs on a minicomputer or a microcomputer.

Identify digital codes and mnemonic codes.

Describe the architecture of microprocessor and micro-computer.

Interface microprocessor with I/O.

Write, debug and run micro-computer programs.

Use control bus for external controllers.

Use standard test equipment and procedure to check performance of electronics system.

Use test equipment to calibrate electronic equipment.

Use test equipment to troubleshoot the malfunctions of electronic equipment.

Radio Communication

Apply FCC rules and regulations to radio communications.

Align IF amplifiers and RF power amplifiers.

Connect, evaluate and troubleshoot amplitude and frequency modulators.

Connect, evaluate and troubleshoot Foster-Seeley discriminator, ratio detector, and quadrature detector.

Connect and align RF tuner.

How important is this skill
to the function of your
Electronic Technicians?

No knowledge necessary					
		Some know- ledge needed			
			Knowledge essential		

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

Radio Communication (Continued)

Connect, evaluate and troubleshoot the balanced modulator.

Identify the principles of telemetry and multiplexer in the
industrial controls.

Operate, monitor and align a transmitter.

How well do you feel the
graduate was prepared to
perform this task?

Unprepared					
		Adequate preparation			
			Excellent preparation		

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

Overall, how qualified were the Wisconsin Technical trained people in the area of job-entry skills.

Unqualified _____

Qualified _____

Well Qualified _____

In what two areas do you feel the Wisconsin Electronic Technician was best prepared?

In what two areas do you feel the Wisconsin Electronic Technician was least adequately prepared?

No. _____ Name _____

 1st letter _____
 2nd letter _____
 returned _____
 Employer: _____
 Interview _____
 mail _____
 no _____

No. _____ Name _____

 1st letter _____
 2nd letter _____
 returned _____
 Employer: _____
 Interview _____
 mail _____
 no _____

No. _____ Name _____

 1st letter _____
 2nd letter _____
 returned _____
 Employer: _____
 Interview _____
 mail _____
 no _____

No. _____ Name _____

 1st letter _____
 2nd letter _____
 returned _____
 Employer: _____
 Interview _____
 mail _____
 no _____